Contents Page

- Title Page [1]
  - Dedication [2]
  - Contents Page [3]
  - Preface [4]
  - Editing, authorship and acknowledgements [5]
  - Part I - Perspectives on plant science [6]
    - Preamble [7]
    - A plant science manifesto [8]
    - A southern hemisphere view of nature [9]
    - Crop adaptation in Australasia [10]
    - Plant science applied: a case study on cotton [11]
    - Synopsis [12]
  - Part II - Processes and resources for growth [13]
    - Chapter 1 - Light use and leaf gas exchange [14]
      - Introduction [15]
      - 1.1 - Leaf anatomy, light interception and gas exchange [16]
        - 1.1.1 - Leaf Structure [17]
        - 1.1.2 Light absorption [18]
        - 1.1.3 CO2 diffusion to chloroplasts [19]
        - 1.1.4 Light and CO2 effects on leaf photosynthesis [20]
      - CASE STUDY 1.1 Development of A:pi curves [21]
      - 1.2 Chloroplasts and energy capture [22]
        - 1.2.1 Chloroplast structure and composition [23]
        - 1.2.2 Chlorophyll absorption and photosynthetic action spectra [24]
        - 1.2.3 Cooperative photosystems and a ‘Z’ scheme for electron flow [25]
        - 1.2.4 Photophosphorylation and ATP synthesis [26]
        - 1.2.5 Chlorophyll fluorescence [27]
      - 1.3 Concluding remarks [28]
      - Further reading [29]

- Chapter 2 - Carbon dioxide assimilation and respiration [30]
  - Introduction [31]
  - 2.1 Modes of photosynthesis [32]
    - 2.1.1 Photosynthetic carbon reduction [33]
    - 2.1.2 RuBP regeneration [34]
    - 2.1.3 Sucrose and starch synthesis [35]
    - 2.1.4 Properties of Rubisco [36]
    - FEATURE ESSAY 2.1 C4 photosynthesis [37]
    - 2.1.5 C4 photosynthesis [38]
    - 2.1.6 Crassulacean acid metabolism (CAM) [39]
    - 2.1.7 Submerged aquatic macrophytes (SAM) [40]
    - 2.1.8 Metabolite flux and organelle transporters [41]
  - 2.2 C4 subgroups [42]
    - 2.2.1 Evolution of the C4 mode [43]
    - 2.2.2 Concentrating CO2 in bundle sheath cells [44]
    - 2.2.3 Regulation of C4 photosynthesis [45]
    - 2.2.4 Environmental physiology [46]
  - 2.3 Photorespiration [47]
    - 2.3.1 Evidence for photorespiration [48]
    - 2.3.2 Substrates for photorespiration [49]
    - 2.3.3 Localisation of photorespiration [50]
    - 2.3.4 C4 plants and unicellular algae [51]
    - 2.3.5 Does photorespiration represent lost productivity? [52]
  - 2.4 Respiration and energy generation [53]
    - 2.4.1 Starch and sucrose degradation [54]
    - 2.4.2 The glycolytic pathway [55]
    - 2.4.3 Pentose phosphate pathway [56]
    - 2.4.4 Mitochondria and organic acid oxidation [57]
    - 2.4.5 Respiratory chain [58]
    - 2.4.6 Oxidative phosphorylation [59]
    - CASE STUDY 2.1 Knobs and ATP synthase [60]
    - 2.4.7 An alternative oxidase [61]
    - FEATURE ESSAY 2.2 Thermogenesis [62]

        - 2.4.8 Interactions between mitochondria and chloroplasts [63]
        - 2.4.9 Energetics of respiration [64]
    - Further Reading [65]
- Chapter 3 - Gaining water and nutrients: root function [66]
    - Introduction [67]
    - 3.1 Root system architecture [68]
        - 3.1.1 Introduction [69]
        - 3.1.2 Root architecture and uptake of nutrients [70]
        - 3.1.3 Root architecture and uptake of water [71]
        - CASE STUDY 3.1 Cluster (proteoid) roots [72]
    - 3.2 Extracting water and nutrients from soil [73]
        - 3.2.1 Where are water and nutrients found in soil? [74]
        - 3.2.2 Water flow through soil to roots [75]
        - 3.2.3 Calculating water depletion around roots [76]
        - 3.2.4 Observations of water uptake by roots [77]
        - 3.2.5 Roots responding to soil constraints [78]
    - 3.3 Soil–root interface [79]
        - 3.3.1 Rhizosphere chemistry [80]
        - 3.3.2 Rhizosphere biology [81]
        - 3.3.3 Costs and benefits of a rhizosphere [82]
    - 3.4 Mycorrhizal associations [83]
        - 3.4.1 Main types of mycorrhizas [84]
        - 3.4.2 Fungus–root interfaces [85]
        - 3.4.3 Functional aspects of mycorrhizas [86]
    - 3.5 Symbiotic nitrogen fixation [87]
        - 3.5.1 Acquiring atmospheric nitrogen [88]
        - 3.5.2 A range of N2-fixing associations [89]
        - 3.5.3 Rhizobial associations [90]
        - 3.5.4 Linking functions with structures [91]
        - FEATURE ESSAY 3.1 Protecting nitrogenase from oxygen [92]
        - 3.5.5 Measuring N2 fixation [93]

- 3.6 Absorption of water and nutrients by roots [94]
  - 3.6.1 Radial uptake: a dynamic component of resource acquisition [95]
  - 3.6.2 Extracting water and nutrients via the rhizosphere [96]
  - 3.6.3 Pathways and fluxes [97]
  - 3.6.4 Barriers to apoplasmic flow [98]
  - 3.6.5 Transport of water and solutes [99]
  - 3.6.6 Testing root function [100]
  - 3.6.7 Axial versus radial flow [101]
- Further reading [102]

- Chapter 4 - Using water and nutrients: cell growth [103]
  - Introduction [104]
  - 4.1 Membrane transport and ion balance [105]
    - 4.1.1 Osmotic engines for plant function [106]
    - 4.1.2 Transport of molecules across cell membranes [107]
    - 4.1.3 Membrane proteins -catalysts for transport [108]
    - CASE STUDY 4.1 The power of biological pumps [109]
  - 4.2 Regulation of nutrient ion exchange [110]
    - 4.2.1 Compartments, channels and transporters [111]
    - 4.2.2 Transport in cells and tissues [112]
    - 4.2.3 Patch clamping [113]
    - 4.2.4 Patch clamping: a window on ion regulation [114]
    - 4.2.5 Turgor pressure controlling ion flow [115]
    - 4.2.6 Transport proteins underlying the dual mechanism of potassium uptake [116]
    - 4.2.7 Regulation of carrier proteins [117]
    - 4.2.8 Nutrient transport through plants [118]
  - 4.3 Cell enlargement [119]
    - 4.3.1 Water relations [120]
    - 4.3.2 Cell wall expansion [121]
    - 4.3.3 Application of water relations equations to growing cells [122]
    - 4.3.4 Cell wall properties: determinants of growth rate [123]

- CASE STUDY 4.2 A perspective on plants: significance of cell walls [124]
- 4.3.5 How rapidly do cell walls respond to changes in P? [125]
- 4.3.6 Biochemical processes in walls of growing cells [126]
- Further reading [127]

Chapter 5 - Vascular integration and resource storage [128]
- Introduction [129]
- 5.1 Long-distance transport of water and nutrients [130]
  - 5.1.1 Introduction [131]
  - 5.1.2 Experimental history: how the Cohesion Theory came to be accepted [132]
  - 5.1.3 Xylem as an effective conduit for sap [133]
  - 5.1.4 Speed of sap flow [134]
  - 5.1.5 Solute transport via transpiration [135]
- 5.2 Vein endings and export pathways [136]
  - 5.2.1 Introduction [137]
  - 5.2.2 The pipeline: leaf vein architecture [138]
  - 5.2.3 Damage control [139]
  - 5.2.4 Unit pipe: generalised vein structure [140]
  - 5.2.5 Water extraction from the pipeline [141]
  - 5.2.6 Solutes in the transpiration stream [142]
  - 5.2.7 Solute recycling: phloem export [143]
  - 5.2.8 Solute recycling: scavenging cells [144]
  - 5.2.9 Solute excretion [145]
- 5.3 Distribution of photoassimilates within plants [146]
  - 5.3.1 Introduction [147]
  - 5.3.2 Source–path–sink concept [148]
  - 5.3.3 Source–path–sink transport processes [149]
  - 5.3.4 Photoassimilate transport and biomass production [150]

        - 5.3.5 Whole-plant distribution of photoassimilate [151]
        - CASE STUDY 5.1 Partitioning of carbon and nitrogen in a legume [152]
    - 5.4 Phloem transport [153]
        - 5.4.1 Introduction [154]
        - 5.4.2 Characteristics of phloem transport [155]
        - 5.4.3 Chemical nature of translocated material [156]
        - 5.4.4 Phloem flux [157]
        - 5.4.5 Mechanism of phloem translocation [158]
        - 5.4.6 Control of assimilate transport from source to sink [159]
    - 5.5 Phloem loading [160]
        - 5.5.1 Introduction [161]
        - 5.5.2 Pathway of phloem loading in source leaves [162]
        - 5.5.3 Mechanisms of phloem loading [163]
        - 5.5.4 Regulation of phloem loading [164]
        - 5.5.5 Sink regulation [165]
    - 5.6 Phloem unloading and sink utilisation [166]
        - 5.6.1 Introduction [167]
        - 5.6.2 Cellular pathways of phloem unloading [168]
        - 5.6.3 Mechanisms of phloem unloading [169]
        - 5.6.4 Sugar metabolism/compartmentation in sinks [170]
        - 5.6.5 Key transfer events in sugar metabolism and compartmentation [171]
        - 5.6.6 Sink control of photoassimilate partitioning [172]
    - Further reading [173]
- Chapter 6 - Growth analysis: a quantitative approach [174]
    - Introduction [175]
    - 6.1 Concepts and techniques [176]
        - 6.1.1 Cell populations [177]
        - 6.1.2 Plant biomass [178]
        - 6.1.3 Leaf area [179]
    - 6.2 Environmental physiology [180]
        - 6.2.1 Light [181]

- 6.2.2 Temperature [182]
- 6.2.3 Carbon dioxide [183]
- 6.2.4 Nutrients (nitrogen and phosphorus) [184]
- 6.2.5 Light x nutrients [185]
- 6.2.6 CO2 x nutrients [186]
- 6.2.7 Water [187]

6.3 Developmental physiology [188]
- 6.3.1 Biomass distribution [189]
- 6.3.2 Size and ontogeny [190]
- 6.3.3 Reproductive development [191]

6.4 Crop growth analysis [192]
- 6.4.1 Concepts [193]
- 6.4.2 Light use efficiency [194]
- 6.4.3 Potential crop growth rate [195]
- 6.4.4 Respiratory losses [196]

6.5 Respiratory efficiency and plant growth [197]
- 6.5.1 Carbon economy of fast- versus slow-growing plants [198]
- 6.5.2 Energy generation [199]
- 6.5.3 Energy utilisation [200]
- 6.5.4 Methodology [201]
- 6.5.5 Energy use by roots [202]
- 6.5.6 Growth efficiency and crop selection [203]
- 6.5.7 Suboptimal environments [204]

6.6 Concluding remarks [205]

Further reading [206]

Part III - Coodination of growth and reproduction [207]

Chapter 7 - Plant growth and options for reproduction [208]

Introduction [209]

7.1 Axial growth: shoot and root development [210]
- 7.1.1 Root apical meristems [211]
- 7.1.2 Shoot apical meristems [212]
- 7.1.3 Meristems as templates for morphogenesis [213]
- 7.1.4 Meristems responding to their environment [214]

7.2 Options for reproduction [215]
- 7.2.1 Timing of reproduction [216]
- 7.2.2 Vegetative options for reproduction [217]
- 7.2.3 Floral biology and sexual reproduction [218]

        - 7.2.4 Sources of genetic variation and restrictions on breeding [219]
        - Feature Essay 7.1 Self and non-self: recognition processes in flowering plants [220]
    - Further reading [221]
- Chapter 8 - Physical cues for growth and reproduction [222]
    - Introduction [223]
    - 8.1 Latent life: dormancy [224]
        - 8.1.1 Dormancy: the phenomenon of suspended animation [225]
        - 8.1.2 Seed dormancy [226]
        - CASE STUDY 8.1 Dormancy in wheat grains: nature and practical application [227]
        - 8.1.3 Bud dormancy [228]
        - 8.1.4 Physiological control of dormancy [229]
    - 8.2 Plant and organ orientation [230]
        - 8.2.1 Gravitropism [231]
        - 8.2.2 Thigmotropism [232]
        - 8.2.3 Phototropism [233]
        - 8.2.4 Overall models for control of tropisms [234]
        - 8.2.5 Nastic movements [235]
    - 8.3 Reproduction [236]
        - 8.3.1 A time to flower [237]
        - 8.3.2 The processes of floral induction and initiation [238]
    - 8.4 Photoreceptors and light cues [239]
        - 8.4.1 Phytochromes — multi-functional light sensors [240]
        - 8.4.2 PHY genes and classes of phytochrome operation [241]
        - 8.4.3 Phytochrome operation and light quantity [242]
        - 8.4.4 phy mutants [243]
        - 8.4.5 Blue-light receptors and responses [244]
        - 8.4.6 Conclusion [245]
    - Further reading [246]
- Chapter 9 - Plant hormones : chemical signalling in plant development [247]

- Introduction [248]
- 9.1 The basis of chemical control of plan development [249]
  - 9.1.1 Signal sources: which tissues make hormones? How are hormones synthesised? [250]
  - 9.1.2 How mobile are plant hormones? [251]
- 9.2 Physiology of hormone action [252]
  - 9.2.1 Signal targets: perception and signal transduction [253]
  - 9.2.2 Diverse roles for plant hormones [254]
  - 9.2.3 Direct effects on cellular processes [255]
  - CASE STUDY 9.1 Models for control of shoot branching: more than just auxin and cytokinin [256]
  - 9.2.4 Modified gene expression [257]
- 9.3 Harnessing hormones: making use of chemical signals [258]
  - 9.3.1 Manipulating growth and development with applied plant growth regulators [259]
  - 9.3.2 Control through genetic alterations [260]
- 9.4 Concluding remarks [261]
- Further reading [262]

Chapter 10 - Differentiation and gene expression [263]

- Introduction [264]
- 10.1 Cellular development and coordination [265]
  - 10.1.1 Generating cells and organelles: control of division processes [266]
  - 10.1.2 Cellular integration [267]
  - FEATURE ESSAY 10.1 Communication between plant cells [268]
- 10.2 Options for differentiation [269]
  - 10.2.1 The concept of totipotency [270]
  - 10.2.2 Types of differentiation [271]
- 10.3 Gene expression [272]
  - 10.3.1 Gene expression and protein synthesis [273]
  - 10.3.2 Genome interactions [274]

        - 10.3.3 Gene regulation during development [275]
        - 10.3.4 Gene expression modified by external factors [276]
        - CASE STUDY 10.1 Plant–pathogen interactions: pathogens as biotic stress factors [277]
    - 10.4 Modified genomes: genetic engineering [278]
        - 10.4.1 Transformation systems [279]
        - 10.4.2 Transgenic plants [280]
    - Further reading [281]
- Chapter 11 - Fruit growth and postharvest physiology [282]
    - Introduction [283]
    - 11.1 Onset of fruit growth [284]
        - 11.1.1 Early events [285]
        - 11.1.2 Origin of fruit tissues [286]
        - 11.1.3 Fruit set [287]
    - 11.2 Dynamics of fruit growth [288]
        - 11.2.1 Time-course [289]
        - 11.2.2 Cell division and enlargement [290]
        - 11.2.3 Cell differentiation [291]
        - 11.2.4 Kiwifruit development: a case study [292]
        - 11.2.5 Seed development and fruit growth [293]
    - 11.3 Resources for fruit growth [294]
        - 11.3.1 Carbohydrate economy [295]
        - 11.3.2 Photoassimilate distribution [296]
        - 11.3.3 Composition of photoassimilates [297]
        - 11.3.4 Fruit composition and sensory attributes [298]
        - 11.3.5 Mineral nutrients [299]
    - 11.4 Maturation and ripening [300]
        - 11.4.1 Carbon accumulation [301]
        - 11.4.2 Sugar storage [302]
        - 11.4.3 Starch storage [303]
    - 11.5 Respiration, climacteric and edibility [304]
        - 11.5.1 Ripening indicators [305]
        - 11.5.2 Climacteric behaviour [306]
        - 11.5.3 Ripening triggers [307]
        - 11.5.4 Texture and softening [308]
        - 11.5.5 Colour and flavour [309]
        - 11.5.6 Ethylene [310]

        - FEATURE ESSAY 11.1 A century of ethylene research [311]
    - 11.6 Extending storage life [312]
        - 11.6.1 Temperature [313]
        - 11.6.2 Relative humidity [314]
        - 11.6.3 Modified and controlled atmospheres [315]
        - 11.6.4 Physiology of controlled atmosphere storage [316]
        - 11.6.5 Storage disorders [317]
    - 11.7 Future technologies [318]
    - 11.8 Concluding remarks [319]
    - Further reading [320]
- Part IV - Ecophysiology in natural and managed communities [321]
    - Chapter 12 - Sunlight: an all pervasive source of energy [322]
        - Introduction [323]
        - 12.1 Photosynthesis in sun and shade [324]
            - 12.1.1 Light interception and utilisation [325]
            - 12.1.2 Photoinhibition and photoprotection [326]
            - FEATURE ESSAY 12.1 Perspectives on photoinhibition [327]
            - 12.1.3 Sun/shade acclimation and rainforest gaps [328]
            - CASE STUDY 12.1 Interaction of light and nutrients on rainforest seedlings [329]
            - 12.1.4 Sunflecks [330]
        - 12.2 Ultraviolet radiation [331]
            - 12.2.1 Ultraviolet radiation on an ancient earth [332]
            - 12.2.2 Ultraviolet attenuation by a modern earth [333]
            - 12.2.3 Ultraviolet radiation and plant biology [334]
        - 12.3 Agricultural production [335]
            - 12.3.1 PAR and yield [336]
            - 12.3.2 Leaf area index and canopy light climate [337]
            - 12.3.3 Light use efficiency [338]
        - 12.4 Forest production [339]
            - 12.4.1 Canopy architecture [340]
            - 12.4.2 Canopy productivity [341]

        - CASE STUDY 12.2 Pine forest canopies and biomass production [342]
    - 12.5 Horticultural production [343]
        - 12.5.1 Sunlight interception [344]
        - 12.5.2 Light climate and fruit quality [345]
        - 12.5.3 Flower bud differentiation and fruit set [346]
        - 12.5.4 Orchard design and canopy management [347]
    - 12.6 Concluding remarks [348]
    - Further reading [349]
- Chapter 13 - Carbon dioxide: a universal substrate [350]
    - Introduction [351]
    - 13.1 Dynamics of atmospheric CO2 [352]
        - 13.1.1 Global carbon cycle [353]
        - 13.1.2 Small-scale variation in CO2 [354]
    - 13.2 Leaf adjustments under CO2 enrichment [355]
        - 13.2.1 C3 plants versus C4 plants [356]
        - 13.2.2 Stomatal conductance [357]
        - 13.2.3 Respiratory adjustments [358]
        - 13.2.4 Ontogeny and duration of CO2 enrichment [359]
        - 13.2.5 Photosynthetic acclimation [360]
        - 13.2.6 Carbon partitioning [361]
    - 13.3 Factor interaction and CO2 enrichment [362]
        - 13.3.1 Light [363]
        - 13.3.2 Sink strength [364]
        - 13.3.3 Temperature [365]
        - 13.3.4 Phenology, temperature and CO2 [366]
        - 13.3.5 Drought [367]
        - 13.3.6 Concluding remarks [368]
        - CASE STUDY 13.1 CO2, cyanide and plant defence [369]
    - 13.4 Horticultural applications of CO2 enrichment [370]
        - 13.4.1 Greenhouse cropping [371]
        - 13.4.2 Vegetables and fruit crops [372]
        - 13.4.3 Ornamentals and nursery stock [373]
        - 13.4.4 Vegetative propagation [374]
    - 13.5 Tropical trees and CO2 enrichment [375]
        - 13.5.1 Global forests [376]

        - 13.5.2 Leaf gas exchange [377]
        - 13.5.3 Temperature x CO2 [378]
        - 13.5.4 Water x CO2 [379]
        - 13.5.5 Growth, competition and ecosystem structure [380]
        - CASE STUDY 13.2 Heat therapy and CO2 [381]
    - 13.6 Concluding remarks [382]
    - Further reading [383]
- Chapter 14 - Temperature: a driving variable for plant growth and development [384]
    - Introduction [385]
    - 14.1 Thermal environment and growth responses [386]
        - 14.1.1 Temperature means and extremes [387]
        - 14.1.2 Plant temperatures [388]
        - 14.1.3 Variation in sensitivity [389]
        - 14.1.4 Biochemistry and basic concepts [390]
    - 14.2 Plant coordination [391]
        - 14.2.1 Photosynthesis [392]
        - 14.2.2 Assimilate transport [393]
        - 14.2.3 Water and nutrient uptake by roots [394]
        - 14.2.4 Growth and development [395]
        - 14.2.5 Plant form [396]
    - 14.3 Field responses [397]
        - 14.3.1 Day/night temperature differential [398]
        - 14.3.2 Thermal time [399]
        - 14.3.3 Response integration [400]
    - 14.4 Chilling injury [401]
        - 14.4.1 Quantifying chilling injury [402]
        - 14.4.2 Ranges of chilling tolerance [403]
        - 14.4.3 Chill hardening [404]
        - 14.4.4 Concluding remarks [405]
    - 14.5 Plant heat budgets [406]
        - 14.5.1 Reflection [407]
        - 14.5.2 Energy emission (reradiation) [408]
        - 14.5.3 Sensible heat exchange [409]
        - 14.5.4 Latent heat transfer [410]
    - 14.6 Frost and freezing injury [411]
        - 14.6.1 Physics and physiology [412]

        - 14.6.2 Alleviating frost damage in horticulture [413]
        - CASE STUDY 14.1 Cold-induced photoinhibition and tree regeneration [414]
    - 14.7 Concluding remarks [415]
    - Further reading [416]
- Chapter 15 - Water: a limiting factor [417]
    - Introduction [418]
    - 15.1 Soil–plant–atmosphere continuum [419]
        - 15.1.1 Water in soils [420]
        - CASE STUDY 15.1 Water-repellent sands [421]
        - 15.1.2 Hydraulic architecture [422]
        - 15.1.3 Soil–plant hydraulic conductivity [423]
        - 15.1.4 Hydraulic lift [424]
        - CASE STUDY 15.2 Pressure–volume curves [425]
    - 15.2 Stomatal physiology [426]
        - 15.2.1 Stomatal structure and function [427]
        - 15.2.2 Solute relations of guard cells [428]
        - 15.2.3 Light, CO2 and stomatal aperture [429]
        - 15.2.4 Leaf to air vapour pressure difference [430]
    - 15.3 Water use by managed plant communities [431]
        - 15.3.1 Water use efficiency of crops [432]
        - 15.3.2 Crop water use and irrigation [433]
        - CASE STUDY 15.3 More plant for less water? [434]
        - 15.3.3 Phenology, drought and yield [435]
        - 15.3.4 Regulated deficits and fruit yield [436]
        - 15.3.5 Drought stress and adaptive responses [437]
        - FEATURE ESSAY 15.1 Resurrection plants [438]
    - 15.4 Water use by natural plant communities [439]
        - 15.4.1 Savanna woodlands [440]
        - 15.4.2 Open forests [441]
        - CASE STUDY 15.4 Plant parasites [442]
        - 15.4.3 Epiphytes [443]

- 15.5 Concluding remarks [444]
- Further reading [445]

- Chapter 16 - Nutrients: a sparse resource [446]
  - Introduction [447]
  - 16.1 Soil formation [448]
  - FEATURE ESSAY 16.1 A brief history of plant nutrition [449]
  - 16.2 Soil–plant nutrient relations [450]
    - CASE STUDY 16.1 Boron toxicity and Australian agriculture [451]
  - 16.3 Nutrient requirements and functional roles [452]
    - 16.3.1 Essential mineral nutrients [453]
    - 16.3.2 Quantitative requirements [454]
    - CASE STUDY 16.2 Nutrient response in Eucalyptus grandis [455]
    - 16.3.3 Deficiencies and responses [456]
    - FEATURE ESSAY 16.2 Sodium in C4 photosynthesis [457]
    - 16.3.4 Diagnosis of deficiencies [458]
    - 16.3.5 Nutrient interactions [459]
  - 16.4 Adaptation to low availability of nutrients [460]
    - 16.4.1 Symbiotic associations [461]
    - CASE STUDY 16.3 Rainforest succession and nitrogen nutrition [462]
    - 16.4.2 Parasitic plants and carnivorous plants [463]
  - 16.5 Soil acidity and toxicities [464]
    - 16.5.1 Soil acidification [465]
    - 16.5.2 Aluminium and manganese toxicities [466]
    - 16.5.3 Serpentine soils and mine tailings [467]
  - 16.6 Concluding remarks [468]
  - Further reading [469]
- Chapter 17 - Salt: an environmental stress [470]
  - Introduction [471]
  - 17.1 Perspectives on salinity [472]
    - 17.1.1 Geographic extent [473]
    - 17.1.2 Sodic soils [474]
    - 17.1.3 Solutes and osmotic pressure [475]
  - 17.2 Growth and cropping responses [476]
    - 17.2.1 Annual plants [477]

        - 17.2.2 Perennial plants [478]
        - 17.2.3 Heritability of salt tolerance [479]
    - 17.3 Halophytes and adaptation to salt [480]
        - CASE STUDY 17.1 Mangroves and saltmarsh communities [481]
        - 17.3.1 Devices to manage leaf salt [482]
        - 17.3.2 Turgor maintenance [483]
        - 17.3.3 Organic solutes as metabolic protectants [484]
        - CASE STUDY 17.2 Aquatic organisms and compatible solutes [485]
    - 17.4 Salt-affected land: utilisation and reclamation [486]
    - Further reading [487]
- Chapter 18 - Waterlogging and submergence: surviving poor aeration [488]
    - Introduction [489]
    - 18.1 Waterlogging and submergence of terrestrial plants [490]
        - 18.1.1 Root-zone aeration [491]
        - 18.1.2 Adaptive responses to waterlogging [492]
        - case study 18.1 Soybean: the unsuspected paludophyte [493]
        - case study 18.2 Swamp paperbark: a coloniser of flooded, saline wetlands [494]
    - 18.2 Seagrasses: angiosperms adapted to sea floors [495]
        - 18.2.1 Evolution of seagrasses [496]
        - 18.2.2 Ecophysiology of seagrasses [497]
        - case study 18.3 Seagrasses: successful marine macrophytes [498]
    - Further reading [499]
- Chapter 19 - Fire: an ecosystem sculpture [500]
    - Introduction [501]
    - 19.1 Physics and chemistry of an ecosystem on fire [502]
        - 19.1.1 Heat [503]
        - 19.1.2 How plant tissues succumb to heat [504]
        - 19.1.3 Temperatures [505]
        - 19.1.4 Summary [506]
    - 19.2 Plants coexisting with fire [507]

        - 19.2.1 Plant responses to fire and smoke [508]
        - 19.2.2 Fires and ecosystem composition [509]
        - 19.2.3 Using fire to manage plants [510]
    - 19.3 Strategies for surviving in fire-prone environments: seeders and resprouters [511]
        - 19.3.1 Introduction [512]
        - 19.3.2 Fire ephemerals: plants that grow from seed banks [513]
        - 19.3.3 Cryptophytes (geophytes): plants that grow from storage organs [514]
        - 19.3.4 Obligate seeders and resprouters: perennial plants that seed or resprout after fire [515]
    - 19.4 Impact of climate change and burning practices on vegetation [516]
        - 19.4.1 Introduction [517]
        - 19.4.2 Pollen evidence indicating changes in vegetation [518]
        - 19.4.3 Fire: an ecosystem sculptor [519]
    - Further reading [520]
- Chapter 20 - Herbicide resistance: a case of rapid evolution [521]
    - Introduction [522]
    - 20.1 Acquiring resistance to herbicides [523]
        - 20.1.1 Lolium rigidum in Australia: a very resistance prone weed! [524]
        - 20.1.2 Rapid development of resistance [525]
    - 20.2 Biochemistry of herbicide resistance [526]
        - 20.2.1 Target site resistance [527]
        - 20.2.2 Non-target site resistance mechanisms [528]
        - 20.2.3 Cross-resistance [529]
        - 20.2.4 Multiple resistance [530]
        - 20.2.5 Lessons to be learnt from herbicide resistance [531]
    - Further reading [532]

Source
URL: http://plantsinaction.science.uq.edu.au/edition1/?q=content/contents-page

Links:
[1] http://plantsinaction.science.uq.edu.au/edition1/?q=content/title-page

[2] http://plantsinaction.science.uq.edu.au/edition1/?q=content/dedication
[3] http://plantsinaction.science.uq.edu.au/edition1/?q=content/contents-page
[4] http://plantsinaction.science.uq.edu.au/edition1/?q=content/preface
[5] http://plantsinaction.science.uq.edu.au/edition1/?q=content/editing-authorship-and-acknowledgements
[6] http://plantsinaction.science.uq.edu.au/edition1/?q=content/part-i-perspectives-plant-science
[7] http://plantsinaction.science.uq.edu.au/edition1/?q=content/preamble
[8] http://plantsinaction.science.uq.edu.au/edition1/?q=content/plant-science-manifesto
[9] http://plantsinaction.science.uq.edu.au/edition1/?q=content/southern-hemisphere-view-nature
[10] http://plantsinaction.science.uq.edu.au/edition1/?q=content/crop-adaptation-australasia
[11] http://plantsinaction.science.uq.edu.au/edition1/?q=content/plant-science-applied-case-study-cotton
[12] http://plantsinaction.science.uq.edu.au/edition1/?q=content/synopsis
[13] http://plantsinaction.science.uq.edu.au/edition1/?q=content/part-ii-processes-and-resources-growth
[14] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-1-light-use-and-leaf-gas-exchange
[15] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction
[16] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-1-leaf-anatomy-light-interception-and-gas-exchange
[17] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-1-1-leaf-structure
[18] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-1-2-light-absorption
[19] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-1-3-co2-diffusion-chloroplasts
[20] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-1-4-light-and-co2-effects-leaf-photosynthesis
[21] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-1-1-development-api-curves
[22] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-chloroplasts-and-energy-capture
[23] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-1-chloroplast-structure-and-composition
[24] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-2-chlorophyll-absorption-and-photosynthetic-action-spectra
[25] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-3-cooperative-photosystems-and-z-scheme-electron-flow
[26] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-4-photophosphorylation-and-atp-synthesis

[27] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-2-5-chlorophyll-fluorescence
[28] http://plantsinaction.science.uq.edu.au/edition1/?q=content/1-3-concluding-remarks
[29] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-9
[30] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-2-carbon-dioxide-assimilation-and-respiration
[31] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-1
[32] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-modes-photosynthesis
[33] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-1-photosynthetic-carbon-reduction
[34] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-2-rubp-regeneration
[35] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-3-sucrose-and-starch-synthesis
[36] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-4-properties-rubisco
[37] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-2-1-c4-photosynthesis
[38] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-5-c4-photosynthesis
[39] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-6-crassulacean-acid-metabolism-cam
[40] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-7-submerged-aquatic-macrophytes-sam
[41] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-1-8-metabolite-flux-and-organelle-transporters
[42] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-2-c4-subgroups
[43] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-2-1-evolution-c4-mode
[44] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-2-2-concentrating-co2-bundle-sheath-cells
[45] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-2-3-regulation-c4-photosynthesis
[46] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-2-4-environmental-physiology
[47] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-photorespiration
[48] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-1-evidence-photorespiration
[49] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-2-substrates-photorespiration
[50] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-3-localisation-

photorespiration
[51] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-4-c4-plants-and-unicellular-algae
[52] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-3-5-does-photorespiration-represent-lost-productivity
[53] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-respiration-and-energy-generation
[54] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-1-starch-and-sucrose-degradation
[55] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-2-glycolytic-pathway
[56] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-3-pentose-phosphate-pathway
[57] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-4-mitochondria-and-organic-acid-oxidation
[58] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-5-respiratory-chain
[59] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-6-oxidative-phosphorylation
[60] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-2-1-knobs-and-atp-synthase
[61] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-7-alternative-oxidase
[62] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-2-2-thermogenesis
[63] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-8-interactions-between-mitochondria-and-chloroplasts
[64] http://plantsinaction.science.uq.edu.au/edition1/?q=content/2-4-9-energetics-respiration
[65] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-10
[66] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-3-gaining-water-and-nutrients-root-function
[67] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-5
[68] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-1-root-system-architecture
[69] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-1-1-introduction
[70] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-1-2-root-architecture-and-uptake-nutrients
[71] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-1-3-root-architecture-and-uptake-water
[72] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-3-1-cluster-proteoid-roots
[73] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-extracting-water-and-nutrients-soil

[74] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-1-where-are-water-and-nutrients-found-soil
[75] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-2-water-flow-through-soil-roots
[76] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-3-calculating-water-depletion-around-roots
[77] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-4-observations-water-uptake-roots
[78] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-2-5-roots-responding-soil-constraints
[79] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-3-soil-root-interface
[80] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-3-1-rhizosphere-chemistry
[81] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-3-2-rhizosphere-biology
[82] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-3-3-costs-and-bene-ts-rhizosphere
[83] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-4-mycorrhizal-associations
[84] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-4-1-main-types-mycorrhizas
[85] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-4-2-fungus-root-interfaces
[86] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-4-3-functional-aspects-mycorrhizas
[87] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-symbiotic-nitrogen-xation
[88] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-1-acquiring-atmospheric-nitrogen
[89] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-2-range-n2-xing-associations
[90] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-3-rhizobial-associations
[91] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-4-linking-functions-structures
[92] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-3-1-protecting-nitrogenase-oxygen
[93] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-5-5-measuring-n2-xation
[94] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-absorption-water-and-nutrients-roots
[95] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-1-radial-uptake-dynamic-component-resource-acquisition

[96] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-2-extracting-water-and-nutrients-rhizosphere
[97] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-3-pathways-and-fluxes
[98] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-4-barriers-apoplasmic-flow
[99] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-5-transport-water-and-solutes
[100] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-6-testing-root-function
[101] http://plantsinaction.science.uq.edu.au/edition1/?q=content/3-6-7-axial-versus-radial-flow
[102] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading
[103] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-4-using-water-and-nutrients-cell-growth
[104] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-7
[105] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-1-membrane-transport-and-ion-balance
[106] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-1-1-osmotic-engines-plant-function
[107] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-1-2-transport-molecules-across-cell-membranes
[108] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-1-3-membrane-proteins-catalysts-transport
[109] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-4-1-power-biological-pumps
[110] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-regulation-nutrient-ion-exchange
[111] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-1-compartments-channels-and-transporters
[112] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-2-transport-cells-and-tissues
[113] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-3-patch-clamping
[114] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-4-patch-clamping-window-ion-regulation
[115] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-5-turgor-pressure-controlling-ion-flow
[116] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-6-transport-proteins-underlying-dual-mechanism-potassium-uptake
[117] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-7-regulation-carrier-proteins
[118] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-2-8-nutrient-transport-through-plants

[119] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-cell-enlargement
[120] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-1-water-relations
[121] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-2-cell-wall-expansion
[122] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-3-application-water-relations-equations-growing-cells
[123] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-4-cell-wall-properties-determinants-growth-rate
[124] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-4-2-perspective-plants-signi-cance-cell-walls
[125] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-5-how-rapidly-do-cell-walls-respond-changes-p
[126] http://plantsinaction.science.uq.edu.au/edition1/?q=content/4-3-6-biochemical-processes-walls-growing-cells
[127] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-0
[128] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-5-vascular-integration-and-resource-storage
[129] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-0
[130] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-long-distance-transport-water-and-nutrients
[131] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-1-introduction
[132] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-2-experimental-history-how-cohesion-theory-came-be-accepted
[133] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-3-xylem-effective-conduit-sap
[134] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-4-speed-sap-flow
[135] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-1-5-solute-transport-transpiration
[136] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-vein-endings-and-export-pathways
[137] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-1-introduction
[138] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-2-pipeline-leaf-vein-architecture
[139] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-3-damage-control
[140] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-4-unit-pipe-generalised-vein-structure
[141] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-5-water-extraction-pipeline

[142] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-6-solutes-transpiration-stream
[143] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-7-solute-recycling-phloem-export
[144] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-8-solute-recycling-scavenging-cells
[145] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-2-9-solute-excretion
[146] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-distribution-photoassimilates-within-plants
[147] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-1-introduction
[148] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-2-source-path-sink-concept
[149] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-3-source-path-sink-transport-processes
[150] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-4-photoassimilate-transport-and-biomass-production
[151] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-3-5-whole-plant-distribution-photoassimilate
[152] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-5-1-partitioning-carbon-and-nitrogen-legume
[153] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-phloem-transport
[154] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-1-introduction
[155] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-2-characteristics-phloem-transport
[156] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-3-chemical-nature-translocated-material
[157] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-4-phloem-flux
[158] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-5-mechanism-phloem-translocation
[159] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-4-6-control-assimilate-transport-source-sink
[160] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-phloem-loading
[161] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-1-introduction
[162] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-2-pathway-phloem-loading-source-leaves
[163] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-3-mechanisms-phloem-loading

[164] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-4-regulation-phloem-loading
[165] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-5-5-sink-regulation
[166] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-phloem-unloading-and-sink-utilisation
[167] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-1-introduction
[168] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-2-cellular-pathways-phloem-unloading
[169] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-3-mechanisms-phloem-unloading
[170] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-4-sugar-metabolismcompartmentation-sinks
[171] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-5-key-transfer-events-sugar-metabolism-and-compartmentation
[172] http://plantsinaction.science.uq.edu.au/edition1/?q=content/5-6-6-sink-control-photoassimilate-partitioning
[173] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-1
[174] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-6-growth-analysis-quantitative-approach
[175] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-8
[176] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-1-concepts-and-techniques
[177] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-1-1-cell-populations
[178] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-1-2-plant-biomass
[179] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-1-3-leaf-area
[180] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-environmental-physiology
[181] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-1-light
[182] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-2-temperature
[183] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-3-carbon-dioxide
[184] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-4-nutrients-nitrogen-and-phosphorus
[185] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-5-light-x-nutrients
[186] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-6-co2-x-nutrients
[187] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-2-7-water
[188] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-3-

developmental-physiology
[189] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-3-1-biomass-distribution
[190] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-3-2-size-and-ontogeny
[191] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-3-3-reproductive-development
[192] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-4-crop-growth-analysis
[193] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-4-1-concepts
[194] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-4-2-light-use-ef-ciency
[195] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-4-3-potential-crop-growth-rate
[196] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-4-4-respiratory-losses
[197] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-respiratory-ef-ciency-and-plant-growth
[198] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-1-carbon-economy-fast-versus-slow-growing-plants
[199] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-2-energy-generation
[200] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-3-energy-utilisation
[201] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-4-methodology
[202] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-5-energy-use-roots
[203] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-6-growth-ef-ciency-and-crop-selection
[204] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-5-7-suboptimal-environments
[205] http://plantsinaction.science.uq.edu.au/edition1/?q=content/6-6-concluding-remarks
[206] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-2
[207] http://plantsinaction.science.uq.edu.au/edition1/?q=content/part-iii-coodination-growth-and-reproduction
[208] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-7-plant-growth-and-options-reproduction
[209] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-9
[210] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-1-axial-growth-shoot-and-root-development
[211] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-1-1-root-apical-meristems

[212] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-1-2-shoot-apical-meristems
[213] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-1-3-meristems-templates-morphogenesis
[214] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-1-4-meristems-responding-their-environment
[215] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-2-options-reproduction
[216] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-2-1-timing-reproduction
[217] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-2-2-vegetative-options-reproduction
[218] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-2-3-floral-biology-and-sexual-reproduction
[219] http://plantsinaction.science.uq.edu.au/edition1/?q=content/7-2-4-sources-genetic-variation-and-restrictions-breeding
[220] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-7-1-self-and-non-self-recognition-processes-flowering-plants
[221] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-4
[222] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-8-physical-cues-growth-and-reproduction
[223] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-10
[224] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-1-latent-life-dormancy
[225] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-1-1-dormancy-phenomenon-suspended-animation
[226] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-1-2-seed-dormancy
[227] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-8-1-dormancy-wheat-grains-nature-and-practical-application
[228] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-1-3-bud-dormancy
[229] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-1-4-physiological-control-dormancy
[230] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-plant-and-organ-orientation
[231] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-1-gravitropism
[232] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-2-thigmotropism
[233] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-3-phototropism
[234] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-4-overall-models-control-tropisms

[235] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-2-5-nastic-movements
[236] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-3-reproduction
[237] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-3-1-time-flower
[238] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-3-2-processes-floral-induction-and-initiation
[239] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-photoreceptors-and-light-cues
[240] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-1-phytochromes-multi-functional-light-sensors
[241] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-2-phy-genes-and-classes-phytochrome-operation
[242] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-3-phytochrome-operation-and-light-quantity
[243] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-4-phy-mutants
[244] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-5-blue-light-receptors-and-responses
[245] http://plantsinaction.science.uq.edu.au/edition1/?q=content/8-4-6-conclusion
[246] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-8
[247] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-9-plant-hormones-chemical-signalling-plant-development
[248] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-11
[249] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-1-basis-chemical-control-plan-development
[250] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-1-1-signal-sources-which-tissues-make-hormones-how-are-hormones-synthesised
[251] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-1-2-how-mobile-are-plant-hormones
[252] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-2-physiology-hormone-action
[253] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-2-1-signal-targets-perception-and-signal-transduction
[254] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-2-2-diverse-roles-plant-hormones
[255] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-2-3-direct-effects-cellular-processes
[256] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-9-1-models-control-shoot-branching-more-just-auxin-and-cytokinin
[257] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-2-4-modi-ed-gene-expression
[258] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-3-harnessing-hormones-making-use-chemical-signals

[259] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-3-1-manipulating-growth-and-development-applied-plant-growth-regulators
[260] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-3-2-control-through-genetic-alterations
[261] http://plantsinaction.science.uq.edu.au/edition1/?q=content/9-4-concluding-remarks
[262] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-3
[263] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-10-differentiation-and-gene-expression
[264] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-2
[265] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-1-cellular-development-and-coordination
[266] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-1-1-generating-cells-and-organelles-control-division-processes
[267] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-1-2-cellular-integration
[268] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-10-1-communication-between-plant-cells
[269] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-2-options-differentiation
[270] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-2-1-concept-totipotency
[271] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-2-2-types-differentiation
[272] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-3-gene-expression
[273] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-3-1-gene-expression-and-protein-synthesis
[274] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-3-2-genome-interactions
[275] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-3-3-gene-regulation-during-development
[276] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-3-4-gene-expression-modi-ed-external-factors
[277] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-10-1-plant-pathogen-interactions-pathogens-biotic-stress-factors
[278] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-4-modi-ed-genomes-genetic-engineering
[279] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-4-1-transformation-systems
[280] http://plantsinaction.science.uq.edu.au/edition1/?q=content/10-4-2-transgenic-plants
[281] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-5
[282] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-11-fruit-

growth-and-postharvest-physiology
[283] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-3
[284] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-1-onset-fruit-growth
[285] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-1-1-early-events
[286] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-1-2-origin-fruit-tissues
[287] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-1-3-fruit-set
[288] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-dynamics-fruit-growth
[289] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-1-time-course
[290] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-2-cell-division-and-enlargement
[291] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-3-cell-differentiation
[292] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-4-kiwifruit-development-case-study
[293] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-2-5-seed-development-and-fruit-growth
[294] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-resources-fruit-growth
[295] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-1-carbohydrate-economy
[296] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-2-photoassimilate-distribution
[297] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-3-composition-photoassimilates
[298] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-4-fruit-composition-and-sensory-attributes
[299] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-3-5-mineral-nutrients
[300] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-4-maturation-and-ripening
[301] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-4-1-carbon-accumulation
[302] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-4-2-sugar-storage
[303] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-4-3-starch-storage
[304] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-respiration-climacteric-and-edibility
[305] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-1-ripening-

indicators
[306] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-2-climacteric-behaviour
[307] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-3-ripening-triggers
[308] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-4-texture-and-softening
[309] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-5-colour-and-flavour
[310] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-5-6-ethylene
[311] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-11-1-century-ethylene-research
[312] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-extending-storage-life
[313] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-1-temperature
[314] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-2-relative-humidity
[315] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-3-modi-ed-and-controlled-atmospheres
[316] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-4-physiology-controlled-atmosphere-storage
[317] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-6-5-storage-disorders
[318] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-7-future-technologies
[319] http://plantsinaction.science.uq.edu.au/edition1/?q=content/11-8-concluding-remarks
[320] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-6
[321] http://plantsinaction.science.uq.edu.au/edition1/?q=content/part-iv-ecophysiology-natural-and-managed-communities
[322] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-12-sunlight-all-pervasive-source-energy
[323] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-4
[324] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-1-photosynthesis-sun-and-shade
[325] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-1-1-light-interception-and-utilisation
[326] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-1-2-photoinhibition-and-photoprotection
[327] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-12-1-perspectives-photoinhibition
[328] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-1-3-sunshade-acclimation-and-rainforest-gaps

[329] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-12-1-interaction-light-and-nutrients-rainforest-seedlings
[330] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-1-4-sunflecks
[331] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-2-ultraviolet-radiation
[332] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-2-1-ultraviolet-radiation-ancient-earth
[333] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-2-2-ultraviolet-attenuation-modern-earth
[334] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-2-3-ultraviolet-radiation-and-plant-biology
[335] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-3-agricultural-production
[336] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-3-1-par-and-yield
[337] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-3-2-leaf-area-index-and-canopy-light-climate
[338] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-3-3-light-use-ef-ciency
[339] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-4-forest-production
[340] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-4-1-canopy-architecture
[341] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-4-2-canopy-productivity
[342] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-12-2-pine-forest-canopies-and-biomass-production
[343] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-5-horticultural-production
[344] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-5-1-sunlight-interception
[345] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-5-2-light-climate-and-fruit-quality
[346] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-5-3-flower-bud-differentiation-and-fruit-set
[347] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-5-4-orchard-design-and-canopy-management
[348] http://plantsinaction.science.uq.edu.au/edition1/?q=content/12-6-concluding-remarks
[349] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-7
[350] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-13-carbon-dioxide-universal-substrate
[351] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-6
[352] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-1-dynamics-

atmospheric-co2
[353] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-1-1-global-carbon-cycle
[354] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-1-2-small-scale-variation-co2
[355] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-leaf-adjustments-under-co2-enrichment
[356] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-1-c3-plants-versus-c4-plants
[357] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-2-stomatal-conductance
[358] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-3-respiratory-adjustments
[359] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-4-ontogeny-and-duration-co2-enrichment
[360] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-5-photosynthetic-acclimation
[361] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-2-6-carbon-partitioning
[362] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-factor-interaction-and-co2-enrichment
[363] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-1-light
[364] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-2-sink-strength
[365] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-3-temperature
[366] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-4-phenology-temperature-and-co2
[367] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-5-drought
[368] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-3-6-concluding-remarks
[369] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-13-1-co2-cyanide-and-plant-defence
[370] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-4-horticultural-applications-co2-enrichment
[371] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-4-1-greenhouse-cropping
[372] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-4-2-vegetables-and-fruit-crops
[373] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-4-3-ornamentals-and-nursery-stock
[374] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-4-4-vegetative-propagation
[375] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-tropical-

trees-and-co2-enrichment
[376] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-1-global-forests
[377] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-2-leaf-gas-exchange
[378] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-3-temperature-x-co2
[379] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-4-water-x-co2
[380] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-5-5-growth-competition-and-ecosystem-structure
[381] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-13-2-heat-therapy-and-co2
[382] http://plantsinaction.science.uq.edu.au/edition1/?q=content/13-6-concluding-remarks
[383] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-11
[384] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-14-temperature-driving-variable-plant-growth-and-development
[385] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-13
[386] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-1-thermal-environment-and-growth-responses
[387] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-1-1-temperature-means-and-extremes
[388] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-1-2-plant-temperatures
[389] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-1-3-variation-sensitivity
[390] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-1-4-biochemistry-and-basic-concepts
[391] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-plant-coordination
[392] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-1-photosynthesis
[393] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-2-assimilate-transport
[394] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-3-water-and-nutrient-uptake-roots
[395] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-4-growth-and-development
[396] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-2-5-plant-form
[397] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-3-field-responses

[398] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-3-1-daynight-temperature-differential
[399] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-3-2-thermal-time
[400] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-3-3-response-integration
[401] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-4-chilling-injury
[402] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-4-1-quantifying-chilling-injury
[403] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-4-2-ranges-chilling-tolerance
[404] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-4-3-chill-hardening
[405] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-4-4-concluding-remarks
[406] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-5-plant-heat-budgets
[407] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-5-1-reflection
[408] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-5-2-energy-emission-reradiation
[409] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-5-3-sensible-heat-exchange
[410] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-5-4-latent-heat-transfer
[411] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-6-frost-and-freezing-injury
[412] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-6-1-physics-and-physiology
[413] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-6-2-alleviating-frost-damage-horticulture
[414] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-14-1-cold-induced-photoinhibition-and-tree-regeneration
[415] http://plantsinaction.science.uq.edu.au/edition1/?q=content/14-7-concluding-remarks
[416] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-12
[417] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-15-water-limiting-factor
[418] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-14
[419] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-1-soil-plant-atmosphere-continuum
[420] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-1-1-water-soils

[421] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-15-1-water-repellent-sands
[422] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-1-2-hydraulic-architecture
[423] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-1-3-soil-plant-hydraulic-conductivity
[424] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-1-4-hydraulic-lift
[425] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-15-2-pressure-volume-curves
[426] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-2-stomatal-physiology
[427] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-2-1-stomatal-structure-and-function
[428] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-2-2-solute-relations-guard-cells
[429] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-2-3-light-co2-and-stomatal-aperture
[430] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-2-4-leaf-air-vapour-pressure-difference
[431] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-water-use-managed-plant-communities
[432] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-1-water-use-ef-ciency-crops
[433] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-2-crop-water-use-and-irrigation
[434] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-15-3-more-plant-less-water
[435] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-3-phenology-drought-and-yield
[436] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-4-regulated-de-cits-and-fruit-yield
[437] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-3-5-drought-stress-and-adaptive-responses
[438] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-15-1-resurrection-plants
[439] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-4-water-use-natural-plant-communities
[440] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-4-1-savanna-woodlands
[441] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-4-2-open-forests
[442] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-15-4-plant-parasites

[443] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-4-3-epiphytes
[444] http://plantsinaction.science.uq.edu.au/edition1/?q=content/15-5-concluding-remarks
[445] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-13
[446] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-16-nutrients-sparse-resource
[447] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-12
[448] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-1-soil-formation
[449] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-16-1-brief-history-plant-nutrition
[450] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-2-soil-plant-nutrient-relations
[451] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-16-1-boron-toxicity-and-australian-agriculture
[452] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-nutrient-requirements-and-functional-roles
[453] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-1-essential-mineral-nutrients
[454] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-2-quantitative-requirements
[455] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-16-2-nutrient-response-eucalyptus-grandis
[456] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-3-de-ciencies-and-responses
[457] http://plantsinaction.science.uq.edu.au/edition1/?q=content/feature-essay-16-2-sodium-c4-photosynthesis
[458] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-4-diagnosis-de-ciencies
[459] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-3-5-nutrient-interactions
[460] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-4-adaptation-low-availability-nutrients
[461] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-4-1-symbiotic-associations
[462] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-16-3-rainforest-succession-and-nitrogen-nutrition
[463] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-4-2-parasitic-plants-and-carnivorous-plants
[464] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-5-soil-acidity-and-toxicities
[465] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-5-1-soil-acidi-cation

[466] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-5-2-aluminium-and-manganese-toxicities
[467] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-5-3-serpentine-soils-and-mine-tailings
[468] http://plantsinaction.science.uq.edu.au/edition1/?q=content/16-6-concluding-remarks
[469] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-14
[470] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-17-salt-environmental-stress
[471] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-15
[472] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-1-perspectives-salinity
[473] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-1-1-geographic-extent
[474] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-1-2-sodic-soils
[475] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-1-3-solutes-and-osmotic-pressure
[476] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-2-growth-and-cropping-responses
[477] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-2-1-annual-plants
[478] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-2-2-perennial-plants
[479] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-2-3-heritability-salt-tolerance
[480] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-3-halophytes-and-adaptation-salt
[481] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-17-1-mangroves-and-saltmarsh-communities
[482] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-3-1-devices-manage-leaf-salt
[483] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-3-2-turgor-maintenance
[484] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-3-3-organic-solutes-metabolic-protectants
[485] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-17-2-aquatic-organisms-and-compatible-solutes
[486] http://plantsinaction.science.uq.edu.au/edition1/?q=content/17-4-salt-affected-land-utilisation-and-reclamation
[487] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-15
[488] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-18-

waterlogging-and-submergence-surviving-poor-aeration
[489] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-16
[490] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-1-waterlogging-and-submergence-terrestrial-plants
[491] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-1-1-root-zone-aeration
[492] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-1-2-adaptive-responses-waterlogging
[493] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-18-1-soybean-unsuspected-paludophyte
[494] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-18-2-swamp-paperbark-coloniser-flooded-saline-wetlands
[495] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-2-seagrasses-angiosperms-adapted-sea-floors
[496] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-2-1-evolution-seagrasses
[497] http://plantsinaction.science.uq.edu.au/edition1/?q=content/18-2-2-ecophysiology-seagrasses
[498] http://plantsinaction.science.uq.edu.au/edition1/?q=content/case-study-18-3-seagrasses-successful-marine-macrophytes
[499] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-16
[500] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-19-fire-ecosystem-sculpture
[501] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-17
[502] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-1-physics-and-chemistry-ecosystem-re
[503] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-1-1-heat
[504] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-1-2-how-plant-tissues-succumb-heat
[505] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-1-3-temperatures
[506] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-1-4-summary
[507] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-2-plants-coexisting-re
[508] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-2-1-plant-responses-re-and-smoke
[509] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-2-2-fires-and-ecosystem-composition
[510] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-2-3-using-re-manage-plants
[511] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-3-strategies-surviving-re-prone-environments-seeders-and-resprouters
[512] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-3-1-

introduction
[513] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-3-2-fire-ephemerals-plants-grow-seed-banks
[514] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-3-3-cryptophytes-geophytes-plants-grow-storage-organs
[515] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-3-4-obligate-seeders-and-resprouters-perennial-plants-seed-or-resprout-after-re
[516] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-4-impact-climate-change-and-burning-practices-vegetation
[517] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-4-1-introduction
[518] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-4-2-pollen-evidence-indicating-changes-vegetation
[519] http://plantsinaction.science.uq.edu.au/edition1/?q=content/19-4-3-fire-ecosystem-sculptor
[520] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-17
[521] http://plantsinaction.science.uq.edu.au/edition1/?q=content/chapter-20-herbicide-resistance-case-rapid-evolution
[522] http://plantsinaction.science.uq.edu.au/edition1/?q=content/introduction-18
[523] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-1-acquiring-resistance-herbicides
[524] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-1-1-lolium-rigidum-australia-very-resistance-prone-weed
[525] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-1-2-rapid-development-resistance
[526] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-biochemistry-herbicide-resistance
[527] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-1-target-site-resistance
[528] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-2-non-target-site-resistance-mechanisms
[529] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-3-cross-resistance
[530] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-4-multiple-resistance
[531] http://plantsinaction.science.uq.edu.au/edition1/?q=content/20-2-5-lessons-be-learnt-herbicide-resistance
[532] http://plantsinaction.science.uq.edu.au/edition1/?q=content/further-reading-18