Preface

The plant vascular system is composed of two conductive tissues, the xylem and phloem, which are responsible for the transport of water and solutes throughout the plant. Xylem cells are reinforced with thick secondary cell walls that also provide much of the plants mechanical strength and are also a source of dietary fiber. The secondary walls present in the xylem also constitute the majority of plant biomass, and consequently interest in the xylem has grown considerably as plant biomass represents a renewable source of energy. The secondary cell walls are composed predominantly of the sugar polymers cellulose and hemicellulose, and as such xylem has huge potential as a source of fermentable sugars. However, in xylem cells the β(1–4) linked glucose that constitutes the cellulose is mostly present in crystalline arrays known as microfibrils, cross-linked with hemicellulose, and surrounded by the phenolic polymer lignin thus making the sugars extremely difficult to extract from plant material, and recalcitrant to digestion. The improvement of genomics, molecular biology, microscopy, and biochemistry techniques has contributed substantially to the understanding of plant vasculature in general, and the xylem in particular, and has enabled researchers to understand and manipulate xylem differentiation and composition in order to increase xylem deposition and improve characteristics such as sugar extractability. This new understanding has come hand in hand with development of novel methods. This book aims to provide detailed accounts of the techniques used for the study and characterization of the plant vascular system, with a central focus on the xylem tissue. To do so, the book is organized in three main parts:

Part 1: Analysis of xylem development (Chapters 1–6)
In this part, the authors describe a range of theoretical and experimental techniques, with a special focus on versatile and informative tools. These include, for example, the use of cell cultures to induce differentiation of different xylem cell types, thus enabling multiple aspects of xylem formation such as gene regulation, cell wall composition, or apoptosis to be studied in a dynamic fashion. Consequently these techniques can provide a source of material required to address novel fundamental questions.

Part 2: Xylem characterization though imaging techniques (Chapters 7–13)
Xylem is challenging to study at the microscopic level, particularly with live imaging, as it is positioned deep within the plant tissue and contains a thick secondary wall. To overcome this problem, a series of improved and novel techniques, described in this part, have been developed in the last few years. These include novel imaging methods and computational analysis that now allow precise quantification and characterization of xylem properties. This set of methods is also generally applicable to studying differentiation and composition in a variety of cellular systems.

Part 3: Analysis of the xylem composition (Chapters 14–18)
The rich polymer diversity that constitutes the xylem secondary wall has been a focus of recent research as they are source for energy, biomaterials, and dietary fibers. The precise characterization and modification of the composition of this cell wall matrix is vital for

utilization of this material for industrial purposes. This important goal has been underpinned with advances in the study of the fundamental processes controlling the deposition of this rich structure. The methods included in Part 3 of this book have been developed to answer such applied and fundamental aims.

Target audience: Plant biochemists, Cell biologists, and Developmental biologists

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