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978-0-521-17745-0 - Hormones, Signals and Target Cells in Plant Development

Daphne J. Osborne and Michael T. McManus

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Hormones, Signals and Target Cells in Plant Development

The term target cell, first conceived in animal biology, is generally taken to mean a cell that has a pre-determined competence to respond in a defined way to a specific hormone signal. In this volume, the authors present the theory that every plant cell is a target cell for one or more of the plant hormones or other regulatory signals. The different types of cells seen in a mature plant arise as a result of selective responses of meristematic cells to chemical inputs. In this context, the authors provide an overview of plant signals as well as evidence for both short- and long-distance cell-to-cell communication. An interpretation of the target cell concept at the biochemical and molecular levels is then presented using a wide range of examples. This volume will serve as a valuable reference for those working in the field of plant developmental biology.

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Preface

This volume presents a conceptual approach to plant cell differentiation that differs in a number of respects from those already present in the literature. We seek to show how every cell has an individual competence to respond to the signal inputs that may impinge upon it and how every cell then has an individual qualitative and quantitative response. Central to this target cell concept is the premise that each cell is selective and can therefore discriminate amongst the many incoming signals to which it is exposed by an ability to perceive them and to respond to them.

Because each cell occupies its individual position within the plant body, the intensity or diversity of the signal inputs that it receives are not themselves identical. Hence, each cell is a unique individual and displays a unique target status even though it may also possess considerable commonality with its neighbours. We define this target status of a cell as the selectivity of its response to a signal and the intensity of that response.

The target cell concept arose originally from notions that were current amongst insect and mammalian scientists stating that a regulatory chemical produced in one organ would be perceived and activated upon by the cells in a distant organ – a specificity that operated between two distinct cell types. As the evidence for specificity of response to hormonal inputs increased during the twentieth century, developmental biologists saw this ability of cells to discriminate amongst the multitude of chemical signals to which they were exposed as a marker of the cell's ability to discriminate between them. For a passing hormone, the cell that responded was a target cell.

For the purposes of this volume, we will consider those signals that are endogenously produced or transmuted to chemical signals within the plant. We define such signals as the agents of cell-to-cell communication. This does not imply, however, that we consider electrical signals, gravity signals or differential light inputs

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to be unimportant, but the scope of this book focuses on the molecular communicators that can be isolated from plants as chemical entities with growth regulatory properties. It is these signal molecules that provide the messages that coordinate the processes of differentiation. We shall not, therefore, consider in any detail the formative influence of all the many external cues that a plant encounters directly from the environment.

Our aim is to present the reader with our interpretation of how the unique target status of each cell is expressed at the biochemical and molecular levels and how this forms the basis for specificity in signal-directed responses. Some of the examples that we discuss here are selected from research studies fitting most easily into the target cell concept. Other examples are those that we have re-interpreted in this light. The target cell concept, as we present it here, has arisen from the many years of our own research. However, it is also our purpose to stimulate debate on the validity of this concept when interpreting other studies of plant cell differentiation and development.

In terms of the structure of the volume, we begin by defining the concept of target cells (Chapter 1), then introduce the repertoire of signals that operate in plants (Chapter 2), and present evidence for both short- and long-distance cell-to-cell signalling (Chapter 3). The concept of the higher plant body in which the majority of cells retain a flexible differentiation status, while some functionally specialised cell types attain a state of terminal commitment, is introduced in Chapter 4. We submit though, that every cell, irrespective of its differentiation status, is a target cell and so we examine the target status of both flexible cell types and terminally committed cell types in Chapters 5 and 6 respectively. Finally, our understanding of the molecular mechanism of hormone action has the potential to be advanced by the identification of receptors and proteinaceous regulators of these signals. In Chapters 7 and 8, we review this literature and speculate on its current and future impact on the target cell concept. In Chapter 9 we consider implications of signal cross-talk.

We hope that this volume will become a useful reference to those working in the field of plant developmental biology.

We wish to acknowledge the assistance of Mrs. Vivian Reynolds, Mrs. Cynthia Cresswell, Ms. Rae Gendall, and Glenda Shaw during the preparation of this volume.