Preface

Respiration is a crucial biochemical process found in all living organisms for meeting their energy demands. A cell adapts to its surroundings and dynamically caters to the energy needs of a wide array of functions. Thus, cells have evolved mechanisms to ingeniously 'switch on' and 'switch off' the different steps of respiratory mechanisms. Among the biochemical processes involved in respiration, three major highly conserved 'classical' pathways are involved; glycolysis, where energy is generated by breaking down glucose; the tricarboxylic acid (TCA) cycle, where the energy is generated in a form that can be used in cellular biochemical reactions; and electron transfer through an electron transport chain to form reducing equivalents leading to the generation ATP. Additionally, plant cells can regulate respiration in a manner deviating from fundamental and generic pathways via so-called alternative respiratory pathways (ARP), which form the focus of this book. While alternative modes of respiration occur in parallel to normal respiration, different sets of regulatory mechanisms are involved in the regulation of genes encoding for the proteins that are involved in alternative pathways. Understanding the regulation of these genes is an important theme in ARP research. Thus, the means through which alternative respiratory processes are regulated to help maintain classical respiration under various stresses or during discrete developmental or ecological conditions, features prominently in ARP publications. Linked to such research are attempts to predict the responses to climate change – changes in temperature, gases, physical vibrations, light, cosmic energy and so on. Even at the shortest and smallest scales, the plant's immediate environment directly influences *in planta* physiological processes – via processes such as respiration – which are ultimately regulated at the genetic level. As a result, on longer and larger spatiotemporal scales, such environmental effects bring about changes in the distribution of plant species and ecosystems. Such changes will in turn also impact on the climate through the exchange of energy and gases among the flora and fauna around them. Equally, a failure to understand and respond to the impacts of climate change on respiration in crops will compromise yield, perturbing food security. Aware of these facts, plant physiologists have focused their research into each aspect of these interactions. A great deal of research has recently been published on how plants display different modes of respiration in different organs by switching over to ARP and on what set of parameters regulate alternative oxidases. To highlight the contribution of ARP to these fundamentally important topics we have brought together scientists with global reputations in the field to

produce what we consider to be an important book with relevance to ecology, plant biodiversity and crop production.

This book therefore considers both classical and alternative respiratory pathways in diverse plant species and in different organs of the same plant at different times of its life cycle. Another driving principle has been to consider the potential applications of this knowledge to plant science and agriculture. The sixteen chapters are split into three sections: the first shows how plant respiratory mechanism have developed to thrive by cleverly rationing cellular energy under differing circumstances, while the second section highlights the application of ARP in plant breeding. The book wraps up the third and final section with the description of important protocols that will be useful for newer researchers.

Within Section A, Chapter 1 introduces readers to the basic principles and the principal difference between classic respiration and the alternative respiratory mechanisms. Complex regulatory mechanisms are described indicating the possibility of not only switching from glycolysis to fermentative metabolism but also the utilization of ARP to maintain substrate oxidation while minimizing the production of ATP. Equally, new insights are indicated on how ATP generation can be maintained under hypoxia. Chapter 2 describes the uncoupling pathways of plant mitochondrial electron transport and the mechanisms variously evolved to maintain the energy flux. How the regulatory proteins – the alternative oxidases – are distributed among the plant kingdom is brought into focus in Chapter 3.

Chapters 4 to 9 deal with alternative respiration under endogenous biochemical perturbations that occur due to certain signal molecules and exogenous stress, as well as how mitochondrial metabolism is regulated and cellular energy is balanced. Chapters 10 and 11 specifically address certain issues related to horticultural commodities – ARP in fruit ripening and in bulky storage tissues.

Section B contains subsections 12 to 14 – a package of 12 chapters – that consider how the molecular information on alternative oxidases may be developed as functional markers in plant breeding programmes. In-depth information is provided by the most renowned experts in the field, discussing how alternative oxidase genes also serve to develop phenotyping tools based on calorespirometry. Since alternative respiratory pathways play a role in the generation of heat during flower blooming and fruit ripening – where heat is needed for emitting volatiles – it serves as an excellent tool for calorespirometric measurements of metabolic heat rates and carbon dioxide rates of respiring tissues as functions of temperature. This enables the rapid responses of plant metabolic events to temperature fluctuations to be determined and, therefore, plant adaptability to environmental conditions to be deduced. Investigating such responses often involves cumbersome and expensive experiments which may be avoided by opting for methods such as calorespirometry. This area has great potential for projecting the effects of global warming on the plant kingdom as a whole and for predicting the geographical distribution of different crops and plant species.

Section C, which includes Chapters 15 and 16, provides updated protocols that describe the steps involved in the isolation of mitochondria for different studies, written by the most experienced workers in the field.

This book, with its breadth of information from the classical understanding of plant respiratory mechanisms to the highly specialized physiological changes that occur in plants during ARP, is expected to find a large readership among life science students and researchers in plant science.

Reputed scientists from nine different countries have contributed to this book and to whom we editors are extremely grateful. We owe our heartfelt gratitude to the internal editors and book publishing staff of John Wiley & Sons, Ltd. for their continuous support and timely advice during the course of the preparation of this volume.

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