

Preface

Mitochondria are the product of a long evolutionary history. It is now a well-established fact that mitochondria did evolve from free living bacteria being the common ancestor of both eukaryotic mitochondria and α -proteobacteria. Advances in genome sequencing, the establishment of in organello and in vitro assays to name only a few, contributed significantly to advances in plant mitochondrial research. Second generation sequencing and the ability to directly sequence and analyze the whole plant transcriptome certainly will help to develop the research on plant mitochondria to another level in the future. In this book the current knowledge about plant mitochondria is presented in a series of detailed chapters, which have been organized in five main parts: (1) dynamics, genes and genomes; (2) transcription and RNA processing; (3) translation and import; (4) biochemistry, regulation and function; and (5) mitochondrial dysfunction and repair. These parts consist of two to five chapters, each written by well-known specialists in the field. The 19 chapters cover the field very well.

In Part I (dynamics, genes and genomes) Volker Knoop (Bonn, Germany) and coworkers provide an insight to the evolution of plant mitochondria which is discussed in the framework of our modern understanding of plant phylogeny. David C. Logan (Saskatchewan, Canada) together with Iain Scott (Bethesda, USA) discuss mitochondrial division and fusion as primary processes controlling mitochondrial form, size, and number. Sally A. Mackenzie together with Maria P. Arrieta-Montiel (Lincoln, USA) reports on the emerging mitochondrial sequence data from early land plants and recent studies of nuclear influence on mitochondrial genome behavior which have provided important insight into the evolutionary trends and possible rationale for the genomic variability that is seen in plant mitochondria.

In Part II (transcription and RNA processing) Thomas Börner and Karsten Liere (Berlin, Germany) discuss the current knowledge about plant mitochondrial transcription, which is sustained by phage-type RNA polymerases that are encoded by a small nuclear encoded gene family. Transcription of most mitochondrial genes is driven by multiple promoters, which may ensure transcription despite possible mitochondrial genome rearrangements. Stefan Binder (Ulm, Germany) and coworkers summarize recent progress made in the understanding of RNA processing and RNA

degradation in mitochondria of higher plants. In the complex framework of plant mitochondria posttranscriptional processes play predominant roles. Linda Bonen (Ottawa, Canada) presents recent advances in our understanding of splicing mechanisms, the nature of splicing machinery, and the relationships among splicing and other RNA processing events in plant mitochondria. Anika Bruhs (Kiel, Germany) and myself present an overview of plant mitochondrial (and plastid) RNA editing, its consequences for translation, the current knowledge of its mechanism, and some ideas on its evolution.

In Part III (translation and import) Nicolas L. Taylor and coworkers (Crawley, Australia) compare the proteomes of mitochondria from monocots and dicots plants and highlight the conservation of the mitochondrial electron transfer chain protein complex I. They also provide important insights, directions, and methodology currently utilized in their laboratory. Laurence Maréchal-Drouard (Strasbourg, France) and coworkers address the basic questions on the tRNA mitochondrial import selectivity, regulation, targeting, and translocation in plants. These data are discussed and compared to what has been discovered in tRNA mitochondrial import in evolutionary divergent organisms. Elzbieta Glaser and James Whelan (Stockholm, Sweden) give an overview on mitochondrial protein import in higher plants. Interestingly, many components of the plant protein import apparatus appear to be different to those in yeast and mammalian systems.

In Part IV (biochemistry, regulation and function), Hans-Peter Braun (Hanover, Germany) and coworkers summarize recent insights into the assembly of the OXPHOS system, consisting of five large multisubunit complexes within the inner mitochondrial membrane, the soluble intermembrane space-localized protein cytochrome c and the lipid ubiquinone. Allan G. Rasmusson (Lund, Sweden) together with Ian M. Møller (Aarhus, Denmark) look at the mitochondrial electron transport chain, which can mediate major adjustments in cellular metabolism important for cellular function under a great variety of stress conditions such as low temperature and drought. Keisuke Yoshida together with Ko Noguchi (Tokyo, Japan) describe and discuss the interaction between chloroplasts and mitochondria and review recent advances of understanding about the activity, function, and regulation of the mitochondrial respiratory system during photosynthesis. David M. Rhoads (Tucson, Arizona) describes plant mitochondria as stress sensors that contribute to decisions regarding cell fate during stresses. These are conveyed to the nucleus by mitochondrial retrograde regulation. Paul F. McCabe (Dublin, Ireland) together with Mark Diamond (Piscataway, USA) discuss the plant mitochondrion as a crucial mediator of programmed cell death. While similarities between plant and animal programmed cell death systems have been discovered, current knowledge suggests there are also key differences.

In Part V (mitochondrial dysfunction and repair) Jenny Carlsson together with Kristina Glimelius (Uppsala, Sweden) report on the current knowledge on cytoplasmic male sterility (CMS) which is caused by mutations, rearrangements, or recombinations in the plant mitochondrial genome. CMS has important applied aspects in plant breeding and is the prime example of mitochondrial dysfunction in higher plants.

However, this book is intended not only for the specialist in plant mitochondria, but also for colleagues from related fields. As such I have invited a few chapters from authors that work on plastids or non-plant systems. These additional chapters provide very important insights into related areas which are not yet developed in plants or are important to understand the level of differences between the plant mitochondrial machinery and other model systems. It seemed prudent to invite Christian Schmitz-Linneweber (Berlin, Germany) and coworkers to add information on RNA binding proteins in plant chloroplast, as there are clear links between plant plastids and mitochondria, e.g., in the field of plant RNA editing. Wolfgang Voos (Bonn, Germany) and coworkers contribution about animal and fungal protein import is a quite logical extension to plant mitochondrial import. Readers can now directly compare fungal or animal protein import with that of plant mitochondria (written by Elzbieta Glaser and James Whelan). Finally, Susan LeDoux (Mobile, USA) provides important insight in human mitochondrial mutations and repair, a field of research which is somewhat related to cytoplasmic male sterility (written by Jenny Carlsson and Kristina Glimelius).

Graduate student and post-docs who recently joined a new field of research often find it difficult to access the literature. Book chapters and reviews written by specialists may contain a tremendous amount of information which literally may overwhelm the inexperienced reader. For easier access to this book, each of its chapters contains a list of abbreviations and a short glossary with explanations for important keywords. Also each chapter contains at least one text box, where more detailed information or cross-reference is given to specific subjects related to the chapter in question. I am sure these measures will not only aid the newcomers to access a complex field but also make the chapters more comprehensive to all readers.

Finally, I would like to thank all the many authors and coauthors who provided great chapters. It was great fun to get this book together. I also would like to thank Hannah Schorr and the publisher for their help and input. I truly hope that this book will help to attract young scientists to the fascinating and exiting field of plant mitochondria.

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