The *Chlamydomonas* Sourcebook

Second Edition

Introduction to Chlamydomonas and Its Laboratory Use

Volume 1

Elizabeth H. Harris

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SECOND EDITION

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Cover image: A cluster of post-mitotic *Chlamydomonas* daughter cells from a mother cell that underwent two rounds of division. Courtesy of Su-chiung Fang and James Umen.

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Preface

When the first edition of *The Chlamydomonas Sourcebook* went to press in 1988, our most urgent issue was to develop methods for transforming *Chlamydomonas* cells with exogenous DNA. Within two years, the transformation problem had been solved through the joint efforts of many members of the Chlamy community (thereby rendering the last part of Chapter 10 obsolete shortly after publication), and *Chlamydomonas* joined the ranks of model organisms that could be manipulated with the tools of molecular biology. Over the past 20 years new lines of research have emerged, new investigators have joined us, a draft genome sequence has been completed, and more than 4000 papers have been published. Clearly it is time for a new edition.

In visiting colleagues over the years I have been pleased to see copies of the first edition of the book on laboratory shelves – and even more pleased when their bindings are disintegrating and pages are stained with green, an indication that I've fulfilled my goal of providing a comprehensive and useful reference tool for the investigator. In thinking about a second edition, this was still a primary objective, but I also realized that one person could no longer cover everything adequately, and that we needed expert reviews of the many aspects of current *Chlamydomonas* research. The three-volume format was developed to meet these requirements.

Volume 1 provides an introduction to *Chlamydomonas* and the essential information for working with it in the laboratory. My target audience is the newcomer to Chlamy, perhaps a graduate student or postdoc, or a more experienced investigator from another discipline who realizes its advantages for a particular study. I hope, however, that old hands will also find interesting and useful information here. Like the first edition, this volume provides historical background that is often neglected, even in review articles, because of page limitations. Some text and many classic figures from the first edition have been retained, but I've tried to bring the overview of research topics up to date.

Volume 2, edited by David Stern, covers the "green side" of Chlamy – chloroplasts, photosynthesis, and related processes – and also various aspects of intermediary metabolism, respiration, and other biochemical functions. Volume 3, edited by George Witman, provides similarly detailed reviews of topics related to flagellar structure and assembly, motility, and behavior. We hope that the whole set will find homes on more laboratory shelves, and that these volumes will acquire their own green stains as *Chlamydomonas* research goes forward.

Elizabeth H. Harris

Acknowledgments

I chose David Stern and George Witman as editors for Volumes 2 and 3, respectively, not only because of their expertise on the topics to be covered, but also because I knew from past experience that both wrote well and were attentive to detail. Although they may never forgive me for persuading them to take on this project, I am immensely grateful to both of them for accepting the challenge, and for the many long hours they have put into producing first-rate books. Thank you for a job well done!

I also want to convey my gratitude to the authors of all the chapters in those volumes. They covered their topics thoroughly and well, and without exception they were quick to respond and never complained about our many requests for changes in the interest of consistency.

Erik Hom, a postdoctoral fellow at Harvard, was my "guinea pig" reader for Volume 1. He reminded me of things that weren't obvious to a Chlamy newcomer, asked good questions, and made many excellent suggestions. I also thank Ursula Goodenough, Thomas Pröschold, and George Witman who read and critiqued chapters. I am grateful to Ron Hoham and Wayne Armstrong for information on red snow algae, and to Judy Acreman, Jerry Brand, Ken Hoober, Bill Inwood, Moira Lawson, Pete Lefebvre, Tasios Melis, Sabeeha Merchant, Saul Purton, Bill Snell, and Jim Umen, who answered questions or sent material on various topics.

Many of the figures used in Volume 1 were carried over from the first edition, and once again I thank everyone who contributed them. For new figures, I thank Annette Coleman, Patricia Daniel, Carol Dieckmann, Susan Dutcher, Mariano García-Blanco, Ursula Goodenough, Ulrich Kück, Matt Laudon, Jae-Hyeok Lee, Telsa Mittelmeier, Jon Nield, Yoshiki Nishimura, Thomas Pröschold, Bill Snell, Jim Umen (who also provided the cover illustration), James Uniacke, Karen VanWinkle-Swift, Sabine Waffenschmidt, Qian Wang, George Witman, and Bill Zerges.

I also want to acknowledge Françoise Bouazzat, Judy Edwards, Maike Lorenz, and Claude Yéprémian for sending photographs that ultimately I didn't use. On the advice of an editor at Elsevier, the decision was made to eliminate color figures from this volume to reduce costs, and as a result I abandoned a plan to include portraits of some notable persons in *Chlamydomonas* research. I hope to be able to post some of these photos on a web site eventually.

Finally, I thank my husband Albert Harris for his companionship and ironic sense of humor that have sustained me through the whole process. For more than 40 years, he's always been there when I needed him. His book will be our next project.

Conventions Used

We assume that the reader is familiar with the basic vocabulary of cell and molecular biology. Abbreviations and acronyms specific to particular areas of research or to *Chlamydomonas* are defined in the list that follows. *Chlamydomonas* is assumed to refer to *C. reinhardtii* unless otherwise specified. The reference genome sequence is the DOE Joint Genome Institute (JGI) version 3.0 (http://www.genome.jgi-psf.org/Chlre3/Chlre3.home.html; Merchant et al., 2007). Supplementary material can be found on the Elsevier companion web site, http://www.elsevierdirect.com/companions/9780123708731.

Nomenclature for genes and proteins follows the guidelines, contributed by S.K. Dutcher and E.H. Harris, in the *Genetic Nomenclature Guide* published by *Trends in Genetics* in 1998, and also summarized at http://www.chlamy.org/nomenclature.html. In brief, genes encoded in the nucleus are designated by uppercase italic letters, often followed by an arabic number to distinguish different loci with the same name (*ARG7*). Three-letter names are preferred. Unless otherwise named, proteins are designated by the relevant uppercase gene symbol, but not italic (e.g., ARG7). Mutant alleles are designated in lowercase italics; different mutant alleles at the same locus are distinguished by a number separated from the gene symbol by a hyphen (e.g., *arg7-1*).

Nomenclature for organelle-encoded genes and their products is based on the system used for cyanobacteria and for plants: gene symbols consist of three letters in lowercase followed by one uppercase letter or number, in italics (*petG*, *rps12*). When a protein has no more familiar name, it may be expressed as the same letters in mixed case, not italics (PetG).

Abbreviations

ATCC	American Type Culture Collection, Rockville, MD, USA
BP	biparental, referring to inheritance of organelle genes from both parents in a cross
CC-	prefix for strains in the Chlamydomonas Resource Center collection
CCAP	Culture Centre of Algae and Protozoa, Oban, Scotland, UK
CCM	carbon concentrating mechanism
CV	contractile vacuole
DAPI	4,6-diamidino-2-phenylindole, a DNA-binding fluorochrome
DCMU	the herbicide 3-(3,4-dichlorophenyl)-1,1-dimethylurea, which inhibits photosynthesis at the level of the PS II reaction center
EM	electron microscopy
EMS	the mutagen ethyl methanesulfonate
IAM	Institute of Applied Microbiology, Tokyo, Japan
IFT	intraflagellar transport
ITS1, ITS2	internal transcribed spacer sequences in the nuclear genes encoding cytosolic ribosomal RNAs
LHCI, LHCII	light-harvesting antennae of photosystems I and II respectively
MID	"minus-dominance," a gene in the *MT* locus of *minus* cells
MMS	the mutagen methyl methanesulfonate
MNNG	the mutagen *N*-methyl-*N*′-nitro-*N*-nitrosoguanidine
MT	mating type locus
ORF	open reading frame
PAR	photosynthetically active radiation
PS I, PS II	photosystem I, photosystem II
QFC	quadriflagellate cell, formed by fusion of *Chlamydomonas plus* and *minus* gametes
Rubisco	ribulose-1,5-bisphosphate carboxylase/oxygenase
SAG	Sammlung von Algenkulturen, Göttingen, Germany
SDR	short dispersed repeat sequences in chloroplast DNA
TAP	Tris-acetate-phosphate culture medium
UP	uniparental, referring to inheritance of organelle genes from only one parent in a cross
UTEX	University of Texas Algal Collection, Austin TX, USA

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