

**MOLECULAR BIOLOGY  
INTELLIGENCE  
UNIT**

**Calreticulin**  
Second Edition

**Paul Eggleton, Ph.D.**

Peninsula Medical School, Devon, U.K.  
MRC Immunochemistry Unit  
Department of Biochemistry  
University of Oxford  
Oxford, U.K.

**Marek Michalak, Ph.D.**

CIHR Membrane Protein Research Group  
Department of Biochemistry  
University of Alberta  
Edmonton, Alberta, Canada

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**CALRETICULIN**  
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**Molecular Biology Intelligence Unit**

Designed by Celeste Carlton

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# CONTENTS

Preface .....	xix
Abbreviations .....	xv
<b>1. Introduction to Calreticulin .....</b>	<b>1</b>
<i>Paul Eggleton and Marek Michalak</i>	
Introduction .....	1
Structure and Function of Calreticulin .....	1
Protein Folding and Quality Control .....	2
Ca <sup>2+</sup> Binding and Ca <sup>2+</sup> Homeostasis .....	2
Immunological Functions of Calreticulin .....	3
What Have We Learned from Calreticulin Gene Knockout? .....	4
Calreticulin and Disease .....	4
Calreticulin and Apoptosis .....	5
Conclusions.....	6
<b>2. Biochemical and Molecular Properties of Calreticulin .....</b>	<b>9</b>
<i>Steven J. Johnson and Kjell O. Häkansson</i>	
Abstract .....	9
Introduction .....	9
Domain Organisation of Calreticulin .....	9
Glycosylation .....	11
Disulphide Bridge .....	11
Phosphorylation .....	11
Recent Structural Studies on Calreticulin .....	11
Structure of the P-Domain .....	12
Structure/Function Relationships—Role of Cations .....	12
Calreticulin Shows Sequence Homology to the Legume Lectins .....	13
Model of Calreticulin—Implications of the Calnexin Structure .....	15
Conclusions.....	15
<b>3. A Chaperone System for Glycoprotein Folding: The Calnexin/Calreticulin Cycle .....</b>	<b>19</b>
<i>Lars Ellgaard and Ari Helenius</i>	
Abstract .....	19
The ER As a Compartment for Protein Folding and Quality Control .....	19
The Calnexin/Calreticulin Cycle .....	20
The Structure of Calnexin and Calreticulin .....	20
GT .....	22
Glucosidase II .....	23
ERp57 .....	23
ERp57 Binds the P-Domain of CRT .....	24
Discussion .....	24

<b>4. Calnexin, an ER Integral Membrane Chaperone in Health and Disease .....</b>	<b>30</b>
<i>John J.M. Bergeron and David Y. Thomas</i>	
Abstract .....	30
Introduction .....	30
The Structure of Calnexin .....	31
Specific Interaction with ERp57 .....	34
Functions of Calnexin, Calreticulin and Calmegin .....	34
Conclusions .....	35
<b>5. Sub-Cellular Distribution of Calreticulin .....</b>	<b>38</b>
<i>Sylvia Papp and Michal Opas</i>	
Abstract .....	38
Introduction .....	38
Endoplasmic Reticulum .....	39
Nucleus and Cytosol .....	41
Cell Surface .....	42
Extracellular .....	43
Concluding Remarks .....	45
<b>6. Calnexin and Calreticulin, Molecular Chaperones of the Endoplasmic Reticulum .....</b>	<b>49</b>
<i>Michael R. Leach and David B. Williams</i>	
Abstract .....	49
Introduction .....	49
Structure and Ligand Binding Properties of CNX and CRT .....	50
Differences in Binding Specificity of CNX and CRT for Newly Synthesized Glycoproteins .....	53
Molecular Chaperone Functions of CNX and CRT .....	53
Mechanisms of Chaperone Action—The “Lectin Only” versus “Dual Binding” Controversy .....	54
Concluding Remarks .....	58
<b>7. Roles of Calreticulin and Calnexin in Myeloperoxidase Synthesis .....</b>	<b>63</b>
<i>William M. Nauseef</i>	
Abstract .....	63
Introduction .....	63
Myeloperoxidase .....	64
The Lectin Chaperones in the Biosynthesis of Normal MPO .....	66
Quality Control in MPO Biosynthesis .....	68
Summary .....	71

<b>8. Calreticulin-Mediated Nuclear Protein Export</b> .....	75
<i>Ben E. Black and Bryce M. Paschal</i>	
Abstract .....	75
Nucleocytoplasmic Transport Pathways .....	75
Purification of CRT Using an Export Assay .....	76
Subcellular Distribution of CRT .....	76
CRT Is the Export Receptor for GR .....	77
Identification of the Export Signal in GR .....	77
The DBD Is Necessary for Export .....	79
Regulating GR Export .....	81
Common Pathways for NR Transport .....	81
Why Do Nuclear Receptors Undergo Export? .....	82
Concluding Remarks .....	83
<b>9. The Role of Calnexin and Calreticulin in MHC Class I Assembly</b> .....	85
<i>Raju Adhikari and Tim Elliott</i>	
Abstract .....	85
Introduction to Class I Assembly .....	85
Functions of Calnexin in Class I Assembly .....	86
Role of Calreticulin in Class I Assembly .....	89
Concluding Remarks .....	91
<b>10. Calreticulin and the Endoplasmic Reticulum in Plant Cell Biology</b> .....	94
<i>Paola Mariani, Lorella Navazio and Anna Zuppini</i>	
Abstract .....	94
Introduction .....	94
Characteristics of Plant Calreticulin .....	94
Intracellular Localization of Calreticulin .....	96
Inducible Expression of Calreticulin .....	97
Endoplasmic Reticulum in Plant Cell Physiology .....	99
Calreticulin and Ca <sup>2+</sup> Signalling .....	101
Note Added in Proof .....	101
<b>11. Modulation of Calcium Homeostasis by the Endoplasmic Reticulum in Health and Disease</b> .....	105
<i>György Szabadkai, Mounia Chami, Paolo Pinton and Rosario Rizzuto</i>	
Abstract .....	105
Regulation of Endoplasmic Reticulum [Ca <sup>2+</sup> ] .....	105
The ER As Central Component of Compartmentalized Ca <sup>2+</sup> Signaling .....	107
ER Calcium Homeostasis, Regulation of Cellular Proliferation and Apoptosis .....	111
Diseases Associated with Ca <sup>2+</sup> Signaling Components of the ER .....	114

<b>12. Calnexin and Calreticulin, ER Associated Modulators of Calcium Transport in the ER</b> .....	126
<i>Patricia Camacho, Linu John, Yun Li, R. Madelaine Paredes and H. Llewelyn Roderick</i>	
Abstract .....	126
Introduction .....	126
<i>Xenopus</i> Oocytes As an Expression System .....	127
Calreticulin and Calnexin Have an Inhibitory Effect on Ca <sup>2+</sup> Oscillations .....	127
Inhibition of Ca <sup>2+</sup> Oscillations Is Mediated by the COOH Terminus of SERCA2b .....	128
Interaction of CNX with the COOH Terminus of SERCA2b .....	129
A PKC Phosphorylation Site in CNX Regulates Inhibition of Ca <sup>2+</sup> Oscillations .....	129
<b>13. ER Calcium and ER Chaperones: New Players in Apoptosis?</b> .....	133
<i>Nicolas Demaurex, Maud Frieden and Serge Arnaudeau</i>	
Abstract .....	133
Introduction .....	133
Role of ER Calcium in Apoptosis .....	134
Role of ER Chaperones in Apoptosis .....	136
<b>14. Calreticulin in Cytotoxic Lymphocyte-Mediated Cytotoxicity</b> .....	142
<i>Dorothy Hudig and Reza Karimi</i>	
Abstract .....	142
Introduction .....	142
Cytotoxic Lymphocytes and the Contents of the Granules .....	143
The Role of Calreticulin in Perforin-Dependent Lysis .....	145
Other Functions for Calreticulin in Immunity .....	148
Conclusions .....	148
<b>15. A Role for Calreticulin in the Clearance of Apoptotic Cells and in the Innate Immune System</b> .....	151
<i>Peter M. Henson</i>	
Abstract .....	151
Introduction .....	151
The Collectin Family of Pattern Recognition, Innate Immune System, Molecules .....	153
Collectin Interaction with Cell Surface Calreticulin .....	154
Interaction of Calreticulin with CD91/LRP As a Mechanism for Initiating Apoptotic Cell Internalization .....	155
Mechanisms of Uptake and Signaling .....	157
Conclusions .....	158

<b>16. Calreticulin and Tumor Suppression</b> .....	162
<i>Giovanna Tosato, Lei Yao and Sandra E. Pike</i>	
Abstract .....	162
Introduction .....	162
Isolation of Calreticulin NH <sub>2</sub> Terminal Fragments and Calreticulin and Their Identification As Inhibitors of Endothelial Cells Proliferation .....	163
Effects of Calreticulin and Calreticulin Fragments on Endothelial Cell Proliferation .....	165
Effects of Calreticulin on Endothelial Cell Attachment .....	167
Calreticulin and Calreticulin N-Domain Inhibit Angiogenesis .....	170
Anti-Tumor Effects of Calreticulin and Calreticulin N-Domain .....	171
Concluding Remarks .....	177
<b>17. Calreticulin's Role(s) in Autoimmune Disorders</b> .....	180
<i>Richard D. Sontheimer, Doina Racila, Emil Racila, Paul Eggleton and Suzanne Donnelly</i>	
Abstract .....	180
Introduction .....	180
Cellular Localization of CRT .....	180
Immune Related Functions of CRT .....	181
CRT As Autoantigen .....	183
How Does CRT Become Accessible to the Adaptive Immune System? .....	185
Why CRT Might Be Targeted As Nonself.....	185
Can the CRT Autoimmune Response Be Viewed As a Heat Shock Response?.....	186
Observed Immunochemical Characteristics of the CRT Aab Response .....	186
CRT Specific Cell Mediated Immune Responses.....	187
Pathogenetic Significance of the CRT Autoimmune Response .....	188
Final Thoughts on the Role of CRT in Autoimmune Disease .....	188
<b>18. Cell Surface Calreticulin: Role in Signaling Thrombospondin Anti-Adhesive Activity</b> .....	193
<i>Silvia M. Goicoechea and J.E. Murphy-Ullrich</i>	
Abstract .....	193
Introduction—Calreticulin: A Ubiquitous Protein with Diverse Functions.....	193
Calreticulin Is a Cell Surface Protein .....	194
TSP-Mediated Focal Adhesion Disassembly .....	194
Cell Adhesion and De-adhesion .....	195
Cell Surface CRT As a Receptor for TSP-Mediated Focal Adhesion Disassembly .....	196
Signaling of CRT/TSP Focal Adhesion Disassembly .....	199
Physiologic Significance of Cell Surface Calreticulin .....	199
Summary and Significance .....	201

<b>19. Calreticulin Regulation of Lung Endothelial NOS Activity</b> .....	<b>205</b>
<i>Jawaharlal M. Patel, Jianliang Zhang, Yong D. Li</i> <i>and Edward R. Block</i>	
Abstract .....	205
Introduction .....	205
Biochemistry and Physiology of Ang-IV .....	206
Calreticulin Expression and Function: Role of Cell	
Stimulation/Injury .....	207
Structure, Function, and Regulation of eNOS Activity .....	208
Ang-IV eNOS Activation: Link to Cellular Calcium	
and Calreticulin .....	209
Concluding Remarks .....	216
<b>20. Role of Calreticulin in <i>Leishmania</i> Parasite Secretory</b>	
<b>    Pathway and Pathogenesis</b> .....	<b>220</b>
<i>Alain Debrabant, Nancy Lee, Dennis M. Dwyer</i> <i>and Hira L. Nakhasi</i>	
Abstract .....	220
<i>Leishmania</i> Biology .....	220
Secretory Pathway in Trypanosomatids .....	222
Characterization of ER Chaperones in Trypanosomatids .....	223
Role of Calreticulin in <i>Leishmania</i> Secretory Pathway .....	225
Dominant-Negative Effect of Expression of Putative	
Domains of LdCR on the Parasite Survival	
in Macrophages in Vitro .....	231
Conclusion .....	234
<b>21. The Hookworm Calreticulin Conundrum</b> .....	<b>238</b>
<i>D.I. Pritchard, N. Girod, A. Brown, R. Caddick, D.S.W. Hooi,</i> <i>R.J. Quinnell, S.J. Johnson and P. Eggleton</i>	
Abstract .....	238
Introduction .....	238
Hookworm Calreticulin May Be Secreted to Perform	
Important Biological Functions at the Host	
Parasite Interface .....	238
Affinity Purification of Native <i>N. americanus</i> Calreticulin .....	239
The True Allergenicity of Hookworm Calreticulin? .....	240
Antigenicity of Hookworm Calreticulin .....	240
The Way Forward .....	246
Summary .....	247



<b>22. Calreticulin in <i>C. elegans</i></b> .....	248
<i>Byung-Jae Park, Jin Il Lee and Joohong Ahnn</i>	
Abstract .....	248
Introduction .....	248
<i>Caenorhabditis elegans</i> As a Model Organism .....	248
<i>crt-1</i> Gene and Protein .....	249
In vitro Function .....	249
The Isolation of <i>C. elegans crt-1</i> Mutants .....	249
In vivo Functions of Calreticulin .....	249
ER-Mediated Calcium Homeostasis and Cell Death .....	251
Defecation Cycle .....	252
<i>crt-1</i> Is Not Essential for Receptor-Mediated Endocytosis .....	252
Future Prospective .....	252
An Evolutionary View of the Functions of Calreticulin .....	253
<b>23. Calreticulin Deficient Mouse</b> .....	258
<i>Lei Guo</i>	
The Calreticulin Gene Knockout Mouse .....	258
Cranial Neural Tube Closure and Umbilical Hernia in Calreticulin-Deficient Embryos .....	258
Cardiac Pathology in Calreticulin-Deficient Embryos .....	260
How Does Calreticulin-Deficiency Result in Impaired Cardiac Development? .....	261
The Calreticulin-Deficient Mouse Shows that Cardiac ER and SR Compartments Are Functionally Distinct .....	262
The Effects of Calreticulin Over-Expression in Postnatal Heart and Its Role in Congenital Complete Heart Block .....	262
Conclusions .....	263
<b>Appendix I: Human Calreticulin Data Sheet</b> .....	267
<i>Paul Eggleton and Marek Michalak</i>	
Previous Names .....	267
Physicochemical Properties .....	267
Mature Protein .....	267
N-Linked Glycosylation Sites (Species Specific) .....	267
Interchain Disulphide Bonds .....	267
Phosphorylation .....	268
Ion-Binding Characteristics .....	268
Gene Structure .....	268
Commercial Antibodies Raised against Calreticulin .....	268
<b>Appendix II: Amino Acid Sequence of Calreticulin</b> .....	271
<b>Index</b> .....	279

# EDITORS

## **Paul Eggleton, Ph.D.**

Peninsula Medical School, Devon, U.K.  
MRC Immunochemistry Unit  
Department of Biochemistry  
University of Oxford  
Oxford, U.K.  
*Chapters 1, 17, 21*

## **Marek Michalak, Ph.D.**

CIHR Membrane Protein Research Group  
Department of Biochemistry  
University of Alberta  
Edmonton, Alberta, Canada  
*Chapter 1*

# CONTRIBUTORS

Raju Adhikari  
Everest Biotech Ltd.  
Oxford Biobusiness Centre  
Littlemore, Oxford, U.K.  
*Chapter 9*

Joohong Ahnn  
Department of Life Science  
Kwangju Institute of Science  
and Technology  
Pukgu, Kwangju, Republic of Korea  
*Chapter 22*

Serge Arnaudeau  
Department of Physiology  
University of Geneva  
Geneva, Switzerland  
*Chapter 13*

John J.M. Bergeron  
Department of Biochemistry  
Department of Anatomy  
and Cell Biology  
McGill University  
Montreal, Quebec, Canada  
*Chapter 4*

Ben E. Black  
Center for Cell Signaling  
Department of Biochemistry  
and Molecular Genetics  
Cell and Molecular Biology Program  
University of Virginia  
Charlottesville, Virginia, U.S.A.  
*Chapter 8*

Edward R. Block  
Division of Pulmonary Medicine  
University of Florida and Research  
Service  
VA Medical Center  
Gainesville, Florida, U.S.A.  
*Chapter 19*

A. Brown  
Boots Science Institute  
School of Pharmaceutical Sciences  
University of Nottingham  
Nottingham, U.K.  
*Chapter 21*

R. Caddick  
Boots Science Institute  
School of Pharmaceutical Sciences  
University of Nottingham  
Nottingham, U.K.  
*Chapter 21*

Patricia Camacho  
Department of Physiology  
University of Texas Health Science  
Center at San Antonio  
San Antonio, Texas, U.S.A.  
*Chapter 12*

Mounia Chami  
Department of Experimental  
and Diagnostic Medicine  
Section of General Pathology  
Center for the Study of Inflammatory  
Diseases (CESMI)  
University of Ferrara  
Ferrara, Italy  
*Chapter 11*

Alain Debrabant  
Division of Emerging and Transfusion  
Transmitted Diseases  
CBER, FDA  
Bethesda, Maryland, U.S.A.  
*Chapter 20*

Nicolas Demaurex  
Department of Physiology  
University of Geneva  
Geneva, Switzerland  
*Chapter 13*

Suzanne Donnelly  
Department of Rheumatology  
St. George's Hospital and Medical School  
London, U.K.  
*Chapter 17*

Dennis M. Dwyer  
Laboratory of Parasitic Diseases  
NIAID, NIH  
Bethesda, Maryland, U.S.A.  
*Chapter 20*

Lars Ellgaard  
Institute of Biochemistry  
ETH Zürich  
Hoenggerberg, Zürich, Switzerland  
*Chapter 3*

Tim Elliott  
Cancer Sciences Division  
University of Southampton School  
of Medicine  
Southampton General Hospital  
Southampton, U.K.  
*Chapter 9*

Maud Frieden  
Department of Physiology  
University of Geneva  
Geneva, Switzerland  
*Chapter 13*

N. Girod  
Boots Science Institute  
School of Pharmaceutical Sciences  
University of Nottingham  
Nottingham, U.K.  
*Chapter 21*

Silvia M. Goicoechea  
Department of Cell and Molecular  
Physiology  
University of North Carolina  
Chapel Hill, North Carolina U.S.A.  
*Chapter 18*

Lei Guo  
CIHR Membrane Protein Research  
Group  
Department of Biochemistry  
University of Alberta  
Edmonton, Alberta, Canada  
*Chapter 23*

Kjell O. Håkansson  
August Krogh Institute  
Laboratory of Cellular and Molecular  
Physiology  
Universitetsparken Copenhagen,  
Denmark  
*Chapter 2*

Ari Helenius  
Institute of Biochemistry  
ETH Zürich  
Hoenggerberg, Zürich, Switzerland  
*Chapter 3*

Peter M. Henson  
Program in Cell Biology  
Department of Pediatrics  
National Jewish Medical and Research  
Center  
Denver, Colorado, U.S.A.  
*Chapter 15*

D.S.W. Hooi  
Boots Science Institute  
School of Pharmaceutical Sciences  
University of Nottingham  
Nottingham, U.K.  
*Chapter 21*

Dorothy Hudig  
Cell and Molecular Biology Program  
School of Medicine  
University of Nevada  
Reno, Nevada, U.S.A.  
*Chapter 14*

Linu John  
Genentech Inc.  
San Francisco, California, U.S.A.  
*Chapter 12*

Steven J. Johnson  
Sir William Dunn School of Pathology  
University of Oxford,  
Oxford, U.K.  
*Chapters 2, 21*

Reza Karimi  
Cell and Molecular Biology Program  
School of Medicine  
University of Nevada  
Reno, Nevada, U.S.A.  
*Chapter 14*

Michael R. Leach  
Department of Biochemistry  
University of Toronto  
Toronto, Ontario, Canada  
*Chapter 6*

Jin Il Lee  
Department of Life Science  
Kwangju Institute of Science  
and Technology  
Pukgu, Kwangju, Republic of Korea  
*Chapter 22*

Nancy Lee  
Division of Emerging and Transfusion  
Transmitted Diseases  
CBER, FDA  
Bethesda, Maryland, U.S.A.  
*Chapter 20*

Yong D. Li  
Division of Pulmonary Medicine  
University of Florida  
Gainesville, Florida, U.S.A.  
*Chapter 19*

Yun Li  
Department of Physiology  
University of Texas Health Science  
Center at San Antonio  
San Antonio, Texas, U.S.A.  
*Chapter 12*

Paola Mariani  
Department of Biology  
University of Padova  
Padova, Italy  
*Chapter 10*

J.E. Murphy-Ullrich  
Cell Adhesion and Matrix Research  
Center  
University of Alabama at Birmingham  
Birmingham, Alabama, U.S.A.  
*Chapter 18*

Hira L. Nakhasi  
Division of Emerging and Transfusion  
Transmitted Diseases  
CBER, FDA  
Bethesda, Maryland, U.S.A.  
*Chapter 20*

William M. Nauseef  
Inflammation Program and Department  
of Medicine  
Roy J. and Lucille A. Carver College  
of Medicine  
University of Iowa and Veterans Affairs  
Medical Center  
Iowa City, Iowa, U.S.A..  
*Chapter 7*

Lorella Navazio  
Department of Biology  
University of Padova  
Padova, Italy  
*Chapter 10*

Michal Opas  
Department of Anatomy and Cell  
Biology  
University of Toronto  
Toronto, Ontario, Canada  
*Chapter 5*

Sylvia Papp  
Department of Anatomy and Cell  
Biology  
University of Toronto  
Toronto, Ontario, Canada  
*Chapter 5*

R. Madelaine Paredes  
Department of Physiology  
University of Texas Health Science  
Center at San Antonio  
San Antonio, Texas, U.S.A.  
*Chapter 12*

Byung-Jae Park  
Department of Life Science  
Kwangju Institute of Science  
and Technology  
Pukgu, Kwangju, Republic of Korea  
*Chapter 22*

Bryce M. Paschal  
Center for Cell Signaling  
Department of Biochemistry  
and Molecular Genetics  
Cell and Molecular Biology Program  
University of Virginia  
Charlottesville, Virginia, U.S.A.  
*Chapter 8*

Jawaharlal M. Patel  
Division of Pulmonary Medicine  
University of Florida and Research  
Service  
VA Medical Center  
Gainesville, Florida, U.S.A.  
*Chapter 19*

Sandra E. Pike  
Experimental Transplantation  
and Immunology Branch  
Center for Cancer Research  
National Cancer Institute  
National Institutes of Health  
Bethesda, Maryland, U.S.A.  
*Chapter 16*

Paolo Pinton  
Department of Experimental  
and Diagnostic Medicine  
Section of General Pathology  
Center for the Study of Inflammatory  
Diseases (CESMI)  
University of Ferrara  
Ferrera, Italy  
*Chapter 11*

D.I. Pritchard  
Boots Science Institute  
School of Pharmaceutical Sciences  
University of Nottingham  
Nottingham, U.K.  
*Chapter 21*

R.J. Quinnell  
School of Biology  
University of Leeds  
Leeds, U.K.

*Chapter 21*

Doina Racila  
Department of Dermatology  
University of Iowa College of Medicine  
Iowa City, Iowa, U.S.A.

*Chapter 17*

Emil Racila  
Holden Cancer Center  
University of Iowa College of Medicine  
Iowa City, Iowa, U.S.A.

*Chapter 17*

Rosario Rizzuto  
Department of Experimental  
and Diagnostic Medicine  
Section of General Pathology  
Center for the Study of Inflammatory  
Diseases (CESMI)

University of Ferrara  
Ferrara, Italy

*Chapter 11*

H. Llewelyn Roderick  
Laboratory of Molecular Signalling  
The Babraham Institute  
Babraham, Cambridge, U.K.

*Chapter 12*

Richard D. Sontheimer  
Department of Dermatology  
University of Iowa College of Medicine  
Iowa City, Iowa, U.S.A.

*Chapter 17*

György Szabadkai  
Department of Experimental  
and Diagnostic Medicine  
Section of General Pathology  
Center for the Study of Inflammatory  
Diseases (CESMI)

University of Ferrara  
Ferrara, Italy

*Chapter 11*

David Y. Thomas  
Department of Biochemistry  
Department of Anatomy and Cell  
Biology

McGill University  
Montreal, Quebec, Canada

*Chapter 4*

Giovanna Tosato  
Experimental Transplantation  
and Immunology Branch  
Center for Cancer Research  
National Cancer Institute  
National Institutes of Health  
Bethesda, Maryland, U.S.A.

*Chapter 16*

David B. Williams  
Department of Biochemistry  
University of Toronto  
Toronto, Ontario, Canada

*Chapter 6*

Lei Yao  
Experimental Transplantation  
and Immunology Branch  
Center for Cancer Research  
National Cancer Institute  
National Institutes of Health  
Bethesda, Maryland, U.S.A.

*Chapter 16*

Jianliang Zhang  
Division of Pulmonary Medicine  
University of Florida  
Gainesville, Florida, U.S.A.

*Chapter 19*

Anna Zuppini  
Department of Biology  
University of Padova  
Padova, Italy

*Chapter 10*

# ABBREVIATIONS

Å	Ångstrom	CN	calcineurin
AAB	autoantibody(s)	CNX	calnexin
ACE	angiotensin converting enzyme	CON A	concanavalin A
ALLM	acetyl-leu-leu-norleucinal	COOH	carboxyl
ALLnL	acetyl-leu-leu-methional	CRT	calreticulin
Ang	angiotensin	CRT-1	<i>C. elegans</i> calreticulin protein
ATP	adenosine triphosphate	<i>crt-1</i>	<i>C. elegans</i> calreticulin gene
β2m	β2-microglobulin	CS	citrate synthase
BAE	bovine aortic endothelial	CTL	cytotoxic T cell
BAPTA-AM	1,2-bis(2-aminophenoxy) ethane-N,N,N,N'-tetraacetic acid-AM	DBD	DNA binding domain
BiP	binding protein	Dex	dexamethasone
BiP	immunoglobulin-heavy-chain-binding protein	DHPR	dihydropyridine receptor
BSA	bovine serum albumin	DNJ	deoxynojirimycin
C1q	first subcomponent of complement 1	EBV	Epstein-Barr virus
C319A	mutant form of myeloperoxidase with the cysteine at codon 319 replaced by alanine	ECM	extracellular matrix
[Ca <sup>2+</sup> ] <sub>cyt</sub>	cytosolic Ca <sup>2+</sup> concentration	EDTA	ethylene diamine tetra-acetic acid (disodium salt)
[Ca <sup>2+</sup> ] <sub>ER</sub>	endoplasmic reticulum luminal Ca <sup>2+</sup> concentration	EGTA	ethylene glycol-bis (?-aminoethyl ether)-N,N', N',N' -tetraacetic acid
Ca	calcium	Endo H	endoglycosidase H
Ca <sup>2+</sup>	calcium	eNOS	endothelial nitric oxide synthase
cADPR	cyclic ADP-ribose	ER	endoplasmic reticulum
CAS	castanospermine	ERAD	ER-associated degradation
cC1qR	collagenous tail C1q receptor	ERK	extracellular signal-regulated kinase
CD	circular dichroism	ERO	endoplasmic reticulum over load
CD8 <sup>+</sup>	cluster of differentiation marker 8-positive cells (T lymphocytes which recognize MHC class I antigens)	ES	excretory-secretory
cGMP	guanosine 3',5'-cyclic monophosphate	ETE	electron transfer control element
CHO	chinese hamster ovary	FACS	fluorescence-activated cell sorting
CICR	Ca <sup>2+</sup> induced Ca <sup>2+</sup> release	FAD	flavin adenine dinucleotide / familial Alzheimer's disease
CK2	casein kinase 2	FBHE	fetal bovine heart endothelial cells
CMG	calmegin	FGF	fibroblast growth factor
		FMN	flavin mononucleotide
		gC1qR	globular head C1q receptor
		GFP	green fluorescent protein

Glc	glucose	MBL	mannose binding lectin (also sometimes called MBP for mannose binding protein)
GlcNAc	N-acetyl glucosamine	MBP	maltose binding protein
GPCRs	G-protein coupled receptors	MEC-4	Na <sup>2+</sup> degenerin channel
GR	glucocorticoid receptor	MEF	mouse embryonic fibroblasts
Gr	granzyme	MHC	major histocompatibility complex
GRP	glucose-regulated proteins	Mig	monokine induced by IFN- $\gamma$
GST	glutathione S-transferase	MMP	mitochondrial membrane permeabilization
GT	UDP-glc:glycoprotein glucosyltransferase	MPO	myeloperoxidase
H chain	heavy chain of class I histocompatibility molecule	mPTP	mitochondrial permeability transition pore
HA	hemagglutinin	Mr	relative molecular mass
HACBP	high affinity calcium-binding protein	mu	map unit
HBD	heparin binding domain	MW	molecular weight
HBV	hepatitis B virus	NAADP	nicotinic acid adenine dinucleotide phosphate
HC	class I heavy chain	NES	nuclear export signal
HOCl	hypochlorous acid	NFAT	nuclear factor of activated T-cells
Hsp	heat shock protein	NIDDM	non-insulin-dependent diabetes mellitus
HUVEC	human umbilical vein endothelial cells	NK	natural killer (lymphocyte)
IFN- $\gamma$	interferon	NLS	nuclear localization signal
InsP <sub>3</sub>	inositol 1,4,5-trisphosphate	NMR	nuclear magnetic resonance
IP	immunoprecipitation	NMR	nuclear magnetic resonance spectroscopy
IP-10	IFN- $\gamma$ inducible protein-10	NO	nitric oxide
IP <sub>3</sub>	inositol 1,4,5 trisphosphate	NOS	nitric oxide synthase
IP <sub>3</sub> R	inositol 1,4,5 trisphosphate receptor	NPC	nuclear pore complex
IRM	interference reflection microscopy	NR	nuclear receptor
KO	knockout	PAGE	polyacrylamide gel electrophoresis
LdCR	<i>Leishmania donovani</i> calreticulin	PCL/PLD	phospholipase C/D
LE	lupus erythematosus		
LMP	latency membrane protein		
LRP	LDL receptor related protein		
LTP	long term potentiation		



PCR	polymerase chain reaction	SPR	surface plasmon resonance
PDI	protein disulfide isomerase	SR	sarcoplasmic reticulum
PDK	proline directed kinase	T	thymically processed lymphocyte
PI3K	phosphoinositide 3-kinase	T134K	threonine to lysine class I heavy chain point mutant at position 134
PIP3	phosphatidylinositol 3,4,5-triphosphate	TAP	transporter associated with Antigen Processing
PKC	protein kinase C	TCR	T cell receptor
PKG	cyclic GMP-dependent protein kinase	TM	transmembrane
PKI	protein kinase inhibitor	TROSY	transverse relaxation-optimized spectroscopy
PLC	phospholipase C	TSP	thrombospondin
PMNs	polymorphonuclear neutrophils	UGGT	UDP-glucose glycoprotein: glucosyltransferase
PS	phosphatidylserine	UPR	unfolded protein response
PTX	pertussis toxin	UV	ultraviolet
QC	quality control	VDAC	voltage dependent anion channel
R569W	mutant form of myeloperoxidase with the arginine at codon 569 replaced by tryptophan	VEGF	vascular endothelial growth factor
rbc=s	red blood cells	VSV	vesicular stomatitis virus
RNase	ribonuclease	VSVG	vesicular stomatitis virus G protein
RyR	ryanodine receptor	WT	wild type
SACP	secretory acid phosphatase	Y173C	mutant form of myeloperoxidase with the tyrosine at codon 173 replaced by cysteine.
SCLE	subacute cutaneous lupus erythematosus	$\Delta\Psi_m$	mitochondrial membrane potential
SERCA	sacroplasmic/endoplasmic reticulum calcium ATPase; $[Ca^{2+}]_{cyt}$ , and $[Ca^{2+}]_{ER}$ , cytosolic and ER free $Ca^{2+}$ concentration, respectively		
SjS	Sjogren's syndrome		
SLE	systemic lupus erythematosus		
SP	mammalian semipermeabilized cell system		
SP-A	surfactant protein A		
SP-D	surfactant protein D		

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## PREFACE

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Calreticulin has been first identified and characterized over 30 years ago as a soluble calcium-binding protein of skeletal muscle sarcoplasmic reticulum. It took over 20 years before it was realized that the protein is in fact a key calcium-binding chaperone of endoplasmic reticulum, a major calcium storage organelle in non-muscle cells. Today calreticulin is considered one of the best markers for the endoplasmic reticulum. The cDNA encoding calreticulin was isolated in 1989, and it was then recognized that the protein plays an important role in virtually every aspect of cell biology. The first edition of calreticulin book was published in 1996. This new edition focuses on the latest discoveries on calreticulin, calnexin (an integral membrane protein similar to calreticulin) and other endoplasmic reticulum proteins. Findings described in the book identify calreticulin and other ER proteins as important molecules involved in many diseases, including protein folding disorders, cardiac pathologies, cancer and autoimmunity. The effects of calreticulin in the modulation of cellular calcium homeostasis have profound effects on many cellular functions. Cell surface calreticulin becomes an important player in modulation of many different pathologies. Gene knockout studies on different animal models point out the critical role of calreticulin in organogenesis and other developmental pathways. Lastly, the structural studies on calreticulin and calnexin revealed a highly unusual three-dimensional arrangement for these chaperones. These observations will undoubtedly have a profound impact on the future studies of other endoplasmic reticulum proteins. The book raises many intriguing questions about calreticulin, calnexin and the endoplasmic reticulum, and gives a unique opportunity to realize the significance of these calcium-binding chaperones.

*Paul Eggleton, Ph.D.*

*Oxford, U.K.*

*Marek Michalak, Ph.D.*

*Edmonton, Alberta, Canada*

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*Marek Michalak, Ph.D.  
Edmonton, Alberta, Canada*

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*Paul Eggleton, Ph.D.  
Oxford, U.K.*