

# Contents

## Volume 1

<i>Contributors</i>	xi	Protein Databases	92
<i>Preface</i>	xxi	<i>Gerritsen Vivienne Baillie and Bairoch Amos</i>	
<i>How to Use This Book</i>	xxi	Protein Denaturation and the Denatured State	98
		<i>Per Hammarström and Bengt-Harald Jonsson</i>	
<b>Introduction</b>		Protein Design	105
History of Protein Chemistry	3	<i>Emmanuel Lacroix and Luis Serrano</i>	
<i>Graeme K Hunter</i>		Protein Family Databases	109
		<i>Nicola J Mulder</i>	
<b>Protein Structure</b>		Protein Motifs: ATP-binding Motifs	114
Amino Acid Side Chain Hydrophobicity	9	<i>Allan Matte and Louis TJ Delbaere</i>	
<i>Hue Sun Chan</i>		Protein Motifs: GTP-binding Loop	118
Amino Acid Substitutions: Effects on Protein Stability	15	<i>Guangpu Li</i>	
<i>Zhiping Weng and Charles DeLisi</i>		Protein Motifs: the Helix-Loop-Helix Motif	123
Evolution of Protein Domains	23	<i>Fred Sablitzky</i>	
<i>Corin A Yeats and Christine A Orengo</i>		Protein Motifs: the Helix-Turn-Helix Motif	127
Hydrogen Bonds in Proteins: Role and Strength	32	<i>Brian W Matthews</i>	
<i>Roderick E Hubbard</i>		Protein Motifs: the Leucine Zipper	132
Hydrophobic Effect	37	<i>Dmitry Krylov and Charles R Vinson</i>	
<i>Judith Herzfeld and Donald J Olbris</i>		Protein Motifs: Zinc-fingers	138
Hydrophobic Interactions in Proteins	45	<i>David Gell, Merlin Crossley and Joel Mackay</i>	
<i>Brian W Matthews</i>		Protein Quaternary Structure: Subunit–Subunit Interactions	143
Immunoglobulin Fold: Structures of Proteins in the Immunoglobulin Superfamily	51	<i>Susan Jones and Janet M Thornton</i>	
<i>Israel M Gelfand, Cyrus Chothia and Alexander E Kister</i>		Protein Quaternary Structure: Symmetry Patterns	149
Mining Biological Databases	58	<i>Ronald E Stenkamp</i>	
<i>Jaime Prilusky</i>		Protein Secondary Structures: Prediction	154
Molten Globule	60	<i>John-Marc Chandonia</i>	
<i>Anthony L Fink</i>		Protein Sequence Databases	159
Peptide Bonds, Disulfide Bonds and Properties of Small Peptides	66	<i>Winona C Barker</i>	
<i>Hiram F Gilbert</i>		Protein Stability	162
Peptides: Biological Activities of Small Peptides	73	<i>C Nick Pace and Gerald R Grimsley</i>	
<i>Amram Mor</i>		Protein Structural Flexibility: Molecular Motions	166
Primary Protein and Nucleic Acid Three-dimensional Structure Databases	81	<i>Richard H Henchman and J Andrew McCammon</i>	
<i>Philip E Bourne</i>		Protein Structure Classification	172
Proline Residues in Proteins	86	<i>Frances MG Pearl, Christine A Orengo and Janet M Thornton</i>	
<i>Charles M Deber and Barbara Brodsky</i>			

Protein Structure: Unusual Covalent Bonds <i>Nancy L Scott and Juliette T J Lecomte</i>	181	Proteases <i>Alan J Barrett and Neil D Rawlings</i>	311
Protein Tertiary Structures: Prediction from Amino Acid Sequences <i>Hongyu Zhang</i>	191	Ubiquitin Pathway <i>Y Amy Lam and Cecile M Pickart</i>	318
Protein Unfolding and Denaturants <i>Lars Konermann</i>	198	<b>Enzymes</b>	
Protein: Cotranslational and Posttranslational Modification in Organelles <i>Doug A Brooks</i>	204	Binding Constants: Measurement and Biological Range <i>Donald J Winzor</i>	327
Proteins: Fundamental Chemical Properties <i>Alain J Cozzone</i>	209	Engineered Enzymes <i>Ben M Dunn</i>	333
Structural Databases of Biological Macromolecules <i>Helen M Berman</i>	218	Enzymatic Rate Enhancements <i>Daniel M Quinn and R Steven Sikorski</i>	340
Unstructured Proteins <i>A Keith Dunker</i>	223	Enzyme Activity: Control <i>Shorena Nadarai, George J Yohrling IV, George C-T Jiang, John M Flanagan and Kent E Vrana</i>	347
<b>Protein Synthesis</b>		Enzyme Classification and Nomenclature <i>Sinead Boyce and Keith F Tipton</i>	355
Chaperones, Chaperonin and Heat-Shock Proteins <i>Valerio Consalvi and Roberta Chiaraluce</i>	235	Enzyme Kinetics: Steady State <i>W Wallace Cleland</i>	365
Chaperonins <i>Valerio Consalvi and Roberta Chiaraluce</i>	241	Enzyme Kinetics: Transient Phase <i>Kenneth A Johnson</i>	370
Codon Usage in Molecular Evolution <i>Richard L Grantham</i>	246	Enzyme Specificity and Selectivity <i>Lizbeth Hedstrom</i>	376
Protein Folding <i>In Vivo</i> <i>Sarah Teter and F Ulrich Hartl</i>	252	Enzymes: General Properties <i>Timothy DH Bugg</i>	383
Protein Synthesis Inhibitors <i>D N Wilson, U Stelzl and Knud H Nierhaus</i>	258	Enzymes: Purification <i>Jerome Salem</i>	390
Protein Synthesis Initiation in Bacteria <i>Marianne Grunberg-Manago</i>	270	Enzymes: The Active Site <i>Eman Ghanem and Frank M Raushel</i>	396
Proteins: Postsynthetic Modification – Function and Physical Analysis <i>Brigitte Wittmann-Liebold and Theodora Choli-Papadopoulou</i>	276	Radical Enzymes <i>Britt-Marie Sjöberg and Margareta Sahlin</i>	403
<b>Protein Degradation</b>		Substrate Binding to Enzymes <i>Vladimir K Pliška</i>	417
Amino Acid Degradation <i>Gary Sawers</i>	287	<b>Enzyme Activity</b>	
Lysosomal Degradation of Proteins <i>J Fred Dice</i>	294	Acid–Base Catalysis by Enzymes <i>Anthony John Kirby</i>	429
Protease Complexes <i>Marion Schmidt and Daniel Finley</i>	301	Binding and Catalysis <i>Michael D Toney</i>	436
		Covalent Nucleophilic Catalysis <i>George L Kenyon</i>	441

Enzymatic Free Radical Reactions <i>Squire J Booker</i>	450	NADP <sup>+</sup> Binding to Dehydrogenases <i>Henry Weiner and Thomas D Hurley</i>	626
Enzyme Activity and Assays <i>Robert K Scopes</i>	465	Protein-derived Cofactors <i>Victor L Davidson</i>	632
Enzyme Activity: Allosteric Regulation <i>Thomas Traut</i>	470	Quinone Cofactors <i>Benjamin Schwartz and Judith P Klinman</i>	636
Enzyme Activity: Reversible Inhibition <i>John F Morrison</i>	482	Thiamin Diphosphate and Vitamin B <sub>1</sub> <i>Susana K Schowen, K Barbara Schowen and Richard L Schowen</i>	642
Enzymes: Irreversible Inhibition <i>Keith F Tipton</i>	490		
Ground State Destabilization <i>Vernon E Anderson</i>	503		
Metalloenzymes and Electrophilic Catalysis <i>Jason Eames and Michael Watkinson</i>	508		
Regulation by Covalent Modification <i>Bruce L Martin</i>	519		
Thermodynamics in Biochemistry <i>Robert A Alberty</i>	525		
Transition State Stabilization <i>Shahriar Mobashery and Lakshmi P Kotra</i>	534		
Transition States: Substrate-induced Conformational Transitions <i>Carol B Post</i>	541		
<b>Enzyme Cofactors</b>			
Cobalamin Coenzymes and Vitamin B <sub>12</sub> <i>Wolfgang Buckel</i>	551		
Coenzymes and Cofactors <i>Joan B Broderick</i>	558		
Coenzymes: Haem <i>Jennifer Cheek and John H Dawson</i>	569		
Enzymes: Coenzyme A Dependent <i>Peter M Shoolingin-Jordan and Matthew P Crump</i>	577		
Enzymes: Phosphopantetheine Dependent <i>Matthew P Crump and Peter M Shoolingin-Jordan</i>	589		
Flavin Coenzymes <i>Sandro Ghisla and Dale E Edmondson</i>	603		
Iron Cofactors: Non-haem <i>Brian G Fox</i>	611		
NAD <sup>+</sup> and NADP <sup>+</sup> as Prosthetic Groups for Enzymes <i>Norman J Oppenheimer</i>	618		
		<b>Volume 2</b>	
		<b>Protein–Ligand Interactions</b>	
		Haemoglobin: Cooperativity in Protein–Ligand Interactions <i>Chien Ho and Jonathan A Lukin</i>	653
		Induced Fit <i>Buyong Ma, Sandeep Kumar, Chung-Jung Tsai, Haim Wolfson, Neeti Sinha and Ruth Nussinov</i>	664
		Protein–Ligand Interactions: Energetic Contributions and Shape Complementarity <i>Chung-Jung Tsai, Raquel Norel, Haim J Wolfson, Jacob V Maizel and Ruth Nussinov</i>	671
		Protein–Ligand Interactions: General Description <i>Michael F Dunn</i>	678
		Protein–Ligand Interactions: Molecular Basis <i>Harvey F Fisher</i>	691
		<b>Protein–Nucleic Acid Interactions</b>	
		DNA Structure Changes Coupled to Protein Binding <i>Mensur Dlakic and Tom K Kerppola</i>	703
		DNA-binding Enzymes: Structural Themes <i>Charles W Knopf and Waldemar Waldeck</i>	712
		Protein Motifs for DNA Binding <i>Hang Xu and Scott W Morrical</i>	723
		Protein–DNA Complexes: Nonspecific <i>Ruth M Saecker</i>	729
		Protein–DNA Complexes: Specific <i>Mark A Strauch</i>	738
		Protein–DNA Interactions <i>Marianne Rooman and René Wintjens</i>	744
		Protein–DNA Interactions: Energetics <i>Tom K Kerppola</i>	752

Protein–DNA Interactions: Polyelectrolyte Effects <i>Ruth M Saecker</i>	760	Electroelution of Proteins from Polyacrylamide Gels <i>Pavel S Gromov and Julio E Celis</i>	867
Protein–Nucleic Acid Interaction: Major Groove Recognition Determinants <i>Yong Xiong and Muttaiya Sundaralingam</i>	766	Expression Tags for Protein Production <i>Su-Ming Hu, Andrew H-J Wang and Ting-Fang Wang</i>	869
Protein–RNA Interactions <i>Felicia Houser-Scott and David R Engelke</i>	773	Gel Electrophoresis of Proteins: High-resolution Two-dimensional <i>Julio E Celis and Pavel S Gromov</i>	875
<b>Protein–Protein Interactions</b>			
Interaction Networks of Proteins <i>Shailesh V Date and Guang Chen</i>	779	Gel Electrophoresis: One-dimensional <i>Andreas Chrambach</i>	879
Protein–Protein Interactions <i>Jeremy H Lakey and Isa Gokce</i>	788	Gel Filtration <i>Lars Hagel</i>	881
<b>Membrane Proteins</b>		Gel Staining Techniques <i>Carl R Merril</i>	884
ATPases: Ion-motive <i>Florent Guillain and Elisabeth Mintz</i>	797	Gene Expression in Yeast <i>Georgios Scheiner-Bobis</i>	889
Clathrin-coated Vesicles and Receptor-mediated Endocytosis <i>Mark Marsh</i>	802	Gene Synthesis for Protein Production <i>Lance Stewart</i>	892
Ion Motive ATPases: V- and P-type ATPases <i>George Sachs and David Keeling</i>	809	Hydrophobic Interaction Chromatography <i>Herbert P Jennissen</i>	903
Membrane Proteins <i>Reinhart AF Reithmeier</i>	821	Immunoglobulin Purification <i>Mark Page</i>	911
Protein Translocation Across Membranes <i>Michael T Ryan and Nikolaus Pfanner</i>	827	Ion Exchange Chromatography <i>David Sheehan and Siobhan O'Sullivan</i>	914
Sodium, Calcium and Potassium Channels <i>Stefan H Heinemann</i>	836	Liquid Chromatography <i>Mohammad Azam Mansoor</i>	917
Water Channels <i>Landon S King and Peter Agre</i>	843	Peptide Mapping <i>Ralph C Judd</i>	921
<b>Techniques: Production, Isolation and Purification</b>		Permeabilized Mammalian Cell Systems for Protein Synthesis <i>Neil J Bulleid</i>	923
Autoradiography and Fluorography <i>Pavel S Gromov and Julio E Celis</i>	851	Protein Determination <i>Martin Guttenberger</i>	925
Baculovirus Expression System <i>Monique M van Oers and Just M Vlak</i>	853	Protein Identification: Overlay Procedures <i>Pavel S Gromov and Julio E Celis</i>	928
Capillary Electrophoresis <i>Pier Giorgio Righetti</i>	855	Protein Production for Biotechnology <i>Sarah E Giuliani, Elizabeth V Landorf and Frank R Collart</i>	931
Chromatofocusing <i>Douglas D Frey, Chittoor R Narahari and Ronald C Bates</i>	858	Protein Production in Mammalian Cells <i>David L Hacker and Florian M Wurn</i>	936
Chromatographic Techniques <i>Alastair C Lewis</i>	861		

Protein Synthesis: Measuring Errors <i>Gregg Bogosian</i>	941	Fluorescent Analogues in Biological Research <i>Joseph R Lakowicz</i>	1027
Solid-phase Peptide Synthesis: Fmoc <i>Chi C Yang</i>	944	Fourier Transform Infrared <i>Johannes Orphal</i>	1037
<b>Techniques: Characterization</b>		Green Fluorescent Protein (GFP) <i>Leila D Hebshi, Brigitte M Angres, Xianqiang L Li and Steven R Kain</i>	1041
Alignment: Statistical Significance <i>Richard Mott</i>	951	Hydrophobicity Plots <i>Mark SP Sansom</i>	1046
Atomic Force Microscopy <i>Martijn de Jager and John van Noort</i>	955	Immuno-electron Microscopy <i>Heinz Schwarz and Heinz Hohenberg</i>	1049
Biological Macromolecules: UV-visible Spectrophotometry <i>Franz-Xaver Schmid</i>	965	Low Angle Scattering of Neutrons and X-rays <i>Jill Trehwella</i>	1054
Calorimetry <i>Kenneth P Murphy</i>	969	Macromolecular Structure Determination by X-ray Crystallography <i>Joachim Jaeger</i>	1059
Centrifugation Techniques <i>David Rickwood</i>	972	Macromolecular Structure Determination: Comparison of Crystallography and NMR <i>J Mitchell Guss and Glenn F King</i>	1066
Circular Dichroism: Studies of Proteins <i>Nicholas C Price</i>	974	Mass Measurements by Scanning Transmission Electron Microscopy <i>David AD Parry</i>	1071
Crystallization of Protein–DNA Complexes <i>Adrian H Batchelor, Derek E Piper and Cynthia Wolberger</i>	979	Mass Spectrometry Instrumentation in Proteomics <i>Peter Roepstorff</i>	1074
Crystallization of Proteins and Protein–Ligand Complexes <i>Alexander McPherson</i>	982	Mass Spectrometry: Analysis of Two-dimensional Protein Gels <i>Hanjo Lim and John R Yates III</i>	1078
Crystallization of Proteins: Two-dimensional <i>Bing K Jap and Peter J Walian</i>	987	Mass Spectrometry: Peptide Sequencing <i>J Throck Watson</i>	1083
Electron Cryomicroscopy <i>Jacques Dubochet and Henning Stahlberg</i>	991	Molecular Dynamics <i>Jarošaw Meller</i>	1087
Electron Cryomicroscopy and Three-dimensional Computer Reconstruction of Biological Molecules <i>Steven J Ludtke and Wah Chiu</i>	996	Mutagenesis: Site-specific <i>M Raafat El-Gewely, Chris Fenton, Elisabeth Kjeldsen and Hao Xu</i>	1095
Electron Paramagnetic Resonance (EPR) and Spin-labelling <i>Peter G Fajer</i>	1001	Normal Mode Analysis in Structural Biology <i>Osamu Miyashita and Florence Tama</i>	1106
Enzymology Methods <i>Robert A Copeland</i>	1007	Nuclear Magnetic Resonance (NMR) Spectroscopy of Proteins <i>Kurt Wüthrich</i>	1115
Flow Cytometers <i>John A Steinkamp</i>	1011	Nuclear Magnetic Resonance (NMR) Spectroscopy: Structural Analysis of Proteins and Nucleic Acids <i>Milton H Werner</i>	1120
Fluorescence Resonance Energy Transfer <i>Deepak Chhabra and Cristobal G dos Remedios</i>	1016		
Fluorescence Spectrophotometry <i>Peter TC So and Chen Y Dong</i>	1023		

Nuclear Magnetic Resonance (NMR): Solid State <i>Stanley J Opella and Francesca M Marassi</i>	1129	Two-dimensional Electron Crystallography <i>Thomas Braun and Andreas Engel</i>	1195
Optical Tweezers <i>Karl Otto Greulich</i>	1133	Two-photon Fluorescence Light Microscopy <i>Peter TC So</i>	1201
Peptide Sequencing by Edman Degradation <i>John Bryan Smith</i>	1137	Ultracentrifugation <i>Alfred Völkl</i>	1206
Phase Problem in X-ray Crystallography, and its Solution <i>Kevin Cowtan</i>	1140	X-ray Absorption Spectroscopy <i>James E Penner-Hahn</i>	1213
Phosphorimager <i>Daniel J Robertson, Willard M Freeman and Kent E Vrana</i>	1145	X-ray Diffraction at Synchrotron Light Sources <i>Jhon R Helliwell</i>	1217
Protein Characterization: Analytical Approaches and Applications to Proteomics <i>Kris Gevaert and Joël Vandekerckhove</i>	1148	X-ray Diffraction: Principles <i>Jan Drenth</i>	1222
Protein Structure Design and Engineering <i>Yi Lu and Steven M Berry</i>	1153	<b>Techniques: Interactions</b>	
Proteomics: A Shotgun Approach without Two-dimensional Gels <i>Claire Delahunty and John R Yates III</i>	1157	Array-based Proteomics <i>Gerald Walter, Konrad Büssow, Zoltan Konthur, Angelika Lueking, Jörn Glökler and Ulrich Schneider</i>	1233
Pulse-field Gel Electrophoresis <i>John C Maule</i>	1162	Immunoprecipitation Techniques <i>Karl-Heinz Scheidtmann</i>	1238
Resonance Raman Spectroscopy <i>Ishita Mukerji</i>	1167	Molecular Entry Point: Strategies in Proteomics <i>Eric T Fung</i>	1243
Sedimentation <i>Thomas Maxon Laue</i>	1171	Protein–DNA Interactions: Techniques Used <i>Mark A Strauch</i>	1248
Single-molecule Light Microscopy <i>Karl Otto Greulich and Volker Uhl</i>	1178	Protein–Ligand Interactions: Computational Docking <i>David Schwarz and Lydia E Kavasaki</i>	1253
Spectroscopic Techniques <i>H Jane Dyson</i>	1181	Protein–Protein Interactions: Identification <i>Matthew E Lopper and James L Keck</i>	1259
Structural Genomics <i>John Norvell, Jiayin Li, Kirstie Saltsman and Jeremy Berg</i>	1185	Protein–Protein Interactions: Prediction <i>Julie C Mitchell</i>	1265
Time-resolved X-ray Crystallography <i>Barry L Stoddard</i>	1189	Proteins: Affinity Tags <i>Shaorong Chong</i>	1270
Transmission Electron Microscopy: Preparation of Specimens <i>Henry S Slayter</i>	1193	Tandem-affinity Purification (TAP) Tags <i>Cynthia Maria Borges Damasceno and Jocelyn Kenneth Campbell Rose</i>	1275