Contents

Preface ..... xiii
List of Contributors ..... xv
Acknowledgements ..... xix

A BASIC STRUCTURAL AND KINETIC ASPECTS 1

1 Sequence-Selective Binding of Transition Metal Complexes to DNA 3
   Einar Sletten and Nils Åge Frøystein
   1.1 Introduction 3
   1.2 Ab initio Calculations and Photo-Cleavage Studies 6
   1.3 NMR Spectroscopic Studies of Metal Binding to DNA Oligonucleotides 9
   1.4 Summary of Theoretical and Experimental Evidence for Sequence–Selective Binding to DNA 22
   1.5 Sequence-Specific Groove Binding 22
Abbreviations 26
References 26

2 Thermodynamic Models of Metal Ion–DNA Interactions 31
   Vasil Bregadze, Eteri Gelagutashvili and Ketevan Tsakadze
   2.1 Introduction 31
   2.2 Interactions of Metal Ions with DNA 33
   2.3 Model and Mechanisms of Metal-Induced Formation of Point Defects 43
   2.4 Conclusions 48
Acknowledgements 49
Abbreviations 49
References 50
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 Specific Binding of Repair Proteins to DNA Modified by Antitumour Platinum Compounds</td>
<td>188</td>
</tr>
<tr>
<td>6.4 Repair of DNA Damage by Antitumour Platinum Compounds</td>
<td>193</td>
</tr>
<tr>
<td>6.5 Implications for Design of New Antitumour Platinum Compounds</td>
<td>200</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>201</td>
</tr>
<tr>
<td>References</td>
<td>201</td>
</tr>
<tr>
<td>7 Telomeres and Telomerase: Potential Targets for Platinum Complexes</td>
<td>209</td>
</tr>
<tr>
<td>Isabelle Ourliac-Garnier, Razan Charif and Sophie Bombard</td>
<td></td>
</tr>
<tr>
<td>7.1 Function of Telomeres</td>
<td>209</td>
</tr>
<tr>
<td>7.2 Structure of Telomeres</td>
<td>210</td>
</tr>
<tr>
<td>7.3 Telomerase</td>
<td>212</td>
</tr>
<tr>
<td>7.4 G-Quadruplex Structures and Small Molecules</td>
<td>213</td>
</tr>
<tr>
<td>7.5 Cisplatin</td>
<td>216</td>
</tr>
<tr>
<td>7.6 Interaction of Cisplatin and Related Platinum Complexes with G-Quadruplex Structures</td>
<td>217</td>
</tr>
<tr>
<td>7.7 Interaction of Cisplatin and Related Platinum Complexes with Telomeric DNA Duplexes</td>
<td>223</td>
</tr>
<tr>
<td>7.8 Interaction of Cisplatin and Related Platinum Complexes with Telomerase</td>
<td>223</td>
</tr>
<tr>
<td>7.9 Conclusion</td>
<td>225</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>226</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>226</td>
</tr>
<tr>
<td>References</td>
<td>226</td>
</tr>
<tr>
<td>8 Towards Photodynamic Therapy of Cancer with Platinum Group Metal Polyazine Complexes</td>
<td>235</td>
</tr>
<tr>
<td>David F. Zigler and Karen J. Brewer</td>
<td></td>
</tr>
<tr>
<td>8.1 Introduction</td>
<td>235</td>
</tr>
<tr>
<td>8.2 Study of Photophysics: Towards PDT</td>
<td>239</td>
</tr>
<tr>
<td>8.3 Photochemical Reactions of Metal Complexes with DNA</td>
<td>255</td>
</tr>
<tr>
<td>8.4 Designing Transition Metal Polyazines for DNA Photomodification</td>
<td>257</td>
</tr>
<tr>
<td>8.5 Cell Studies with Metal Complexes</td>
<td>263</td>
</tr>
<tr>
<td>8.6 Conclusions and Future Directions</td>
<td>266</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>267</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>268</td>
</tr>
<tr>
<td>References</td>
<td>269</td>
</tr>
<tr>
<td>9 Platinated Oligonucleotides: Synthesis and Applications for the Control of Gene Expression</td>
<td>273</td>
</tr>
<tr>
<td>Vicente Marchán and Anna Grandas</td>
<td></td>
</tr>
<tr>
<td>9.1 Therapeutic Applications of Synthetic Oligonucleotides</td>
<td>273</td>
</tr>
<tr>
<td>9.2 Platination as a Tool to Enhance Biological Effects</td>
<td>276</td>
</tr>
</tbody>
</table>
9.3 Synthesis of Platinated Oligonucleotides 279
9.4 Use of Platinated Oligonucleotides for Duplex Crosslinking 289
9.5 Use of Platinated Oligonucleotides for Triplex Crosslinking 294
References 295

10 Rhodium– and Tin–DNA Interactions and Applications 301
Kenneth D. Camm and Patrick C. McGowan
10.1 Introduction 301
10.2 Metal–DNA Interactions 302
10.3 Rhodium–DNA Interactions 302
10.4 Tin–DNA Interactions 308
References 311

C DNA RECOGNITION: NUCLEASES AND SENSORS 317

11 Groove-Binding Ruthenium(II) Complexes as Probes of DNA Recognition 319
Jayden A. Smith, J. Grant Collins and F. Richard Keene
11.1 Introduction 319
11.2 Mononuclear Complexes 320
11.3 Dinuclear Complexes 324
11.4 Potential Biological Significance 338
Abbreviations of Ligands 339
References 340

12 DNA Recognition and Binding by Peptide–Metal Complex Conjugates 347
Alexandra Myari and Nick Hadjiliadis
12.1 Introduction 347
12.2 Transition Metal Complex–Peptide Conjugates 349
12.3 Metallointercalator–Metallopeptide Conjugates 358
12.4 A Critical Survey and Future Perspectives 359
12.5 Conclusion 362
Abbreviations 362
References 363

13 Artificial Restriction Agents: Hydrolytic Agents for DNA Cleavage 369
Fabrizio Mancin and Paolo Tecilla
13.1 Introduction 369
13.2 DNA Hydrolysis 370
13.3 Free Ions and Mononuclear Complexes 373
13.4 Bimetallic Complexes 377
13.5 Conjugation with DNA-affine Subunits 380
13.6 Conjugation with Sequence-Selective Elements 384
13.7 The ARCUT System 385
13.8 A Critical Survey and New Perspectives 386
13.9 Conclusions 389
Acknowledgements 389
References 390

14 New Metallo-DNAzymes: Fundamental Studies of Metal–DNA Interactions and Metal Sensing Applications 395
Zehui Cao and Yi Lu
14.1 Introduction 395
14.2 Metal Ions as Important Cofactors of DNAzymes 396
14.3 Selection of DNAzymes Using in vitro Evolution 397
14.4 Understanding Nucleic Acid Enzyme–Metal Ion Interactions 399
14.5 DNAzymes as Metal Ion Sensors 403
14.6 Summary 410
Acknowledgements 411
References 411

15 Two-Metal-Ion-Dependent Catalysis in Nucleic Acid Enzymes 415
Wei Yang
15.1 Chemistry of Nucleic Acid Synthesis, Cleavage and Strand Transfer 415
15.2 All DNA and RNA Polymerases Require Two Mg$^{2+}$ Ions for Catalysis 417
15.3 Nucleases That Require Two Mg$^{2+}$ Ions in the Active Site 420
15.4 Advantages of Two-Metal-Ion Catalysis: Specificity and Versatility 428
15.5 Concluding Remarks 430
Acknowledgements 430
References 430

D TOXICOLOGICAL ASPECTS 437

16 Structural Studies on the Mercury$^{ll}$-Mediated T-T Base-Pair Using NMR Spectroscopy 439
Yoshiyuki Tanaka and Akira Ono
16.1 The History of the Mercury$^{ll}$–Mediated Thymine-Thymine Base Pair 439
16.2 Crystallographic Studies On Hg$^{ll}$–Nucleobase Complexes 440
16.3 UV, UVCD and Vibrational (Ir/Raman) Spectral Studies 441
16.4 NMR Spectral Studies 444
16.5 Relationship Between $^{15}$n Chemical Shifts and Chemical Bonds 452
16.6 Applications of the T-Hg$^{ll}$-T Base Pair 454
16.7 Biological Relevance of T-Hg$^{ll}$-T Base Pairs 455
16.8 Concluding Remarks 457
References 457

17 Chromium-Induced DNA Damage and Repair 463
Laura G. Little and Kent D. Sugden
17.1 Introduction 463
17.2 Nucleobase Oxidation 468