

1 DNA structure	1
1.1 Introduction	1
1.2 DNA structures	1
1.2.1 <i>The Watson-Crick model</i>	1
1.2.2 <i>B-form DNA</i>	6
1.2.3 <i>A-form DNA</i>	7
1.2.4 <i>Z-form DNA</i>	7
1.3 Alternative DNA structures	8
1.3.1 <i>Cruciforms and Holliday junctions</i>	8
1.3.2 <i>DNA triplexes and H-DNA</i>	12
1.3.3 <i>Telomeres and DNA quadruplexes</i>	13
1.4 Intrinsic curvature and DNA flexibility	15
1.4.1 <i>Intrinsic curvature</i>	16
1.4.2 <i>DNA flexibility</i>	18
1.4.3 <i>Protein-induced DNA bending</i>	18
1.5 Conclusions	19
1.6 Further Reading	20
1.7 References	20
2 DNA supercoiling	25
2.1 Introduction	25
2.2 Historical perspective	25
2.2.1 <i>The problem of the double helix</i>	25
2.2.2 <i>Closed-circular DNA and supercoiling</i>	27
2.3 A quantitative measure of DNA supercoiling	31
2.3.1 <i>Linking number</i>	31
2.3.2 <i>Supercoiling, linking difference, and specific linking difference</i>	34
2.4 Geometrical properties of closed-circular DNA	36
2.4.1 <i>Twist and writhe</i>	36
2.4.2 <i>The interconversion of twist and writhe</i>	37

2.4.3	<i>Plectonemic and toroidal conformations</i>	41
2.4.4	<i>Nomenclature</i>	42
2.5	Topology and geometry of real DNA	43
2.5.1	<i>Agarose gel electrophoresis of plasmids</i>	43
2.5.2	<i>Relaxation with topoisomerases</i>	44
2.5.3	<i>The effect of solution conditions on supercoiling</i>	45
2.5.4	<i>The effect of intercalators</i>	48
2.5.5	<i>Two-dimensional gels</i>	50
2.5.6	<i>Relaxation in the presence of intercalators</i>	53
2.5.7	<i>The effect of protein binding</i>	55
2.6	Thermodynamics of DNA supercoiling	55
2.6.1	<i>Ethidium bromide titration</i>	56
2.6.2	<i>The Gaussian distribution of topoisomers</i>	57
2.6.3	<i>The effect of DNA circle size</i>	60
2.6.4	<i>Supercoiling free energy and solution conditions</i>	61
2.6.5	<i>Supercoiling in small DNA circles</i>	63
2.7	Theoretical approaches to DNA supercoiling	65
2.7.1	<i>Bending and twisting rigidity and persistence length</i>	66
2.7.2	<i>Excluded volume and effective diameter</i>	68
2.7.3	<i>Simulations of DNA conformation and energetics</i>	70
2.7.4	<i>Applications of circular DNA simulations</i>	72
2.8	Biological effects of supercoiling free energy	75
2.8.1	<i>Stabilization of alternative structures by DNA supercoiling</i>	75
2.9	Conclusions	77
2.10	Further Reading	77
2.11	References	78
3	DNA on surfaces	83
3.1	Introduction	83
3.2	The helical repeat of DNA	84
3.3	The surface linking treatment	87
3.3.1	<i>DNA winding number (Φ)</i>	87
3.3.2	<i>Surface linking number (SLk)</i>	88
3.4	Interwound supercoiled DNA	90
3.5	The nucleosome	93
3.5.1	<i>Linking difference and the 'linking number paradox'</i>	93

6 Biological consequences of DNA topology	145
6.1 Introduction: the ubiquity of topology	145
6.1.1 General biological consequences of negative supercoiling	146
6.2 Genome organization	148
6.2.1 Prokaryotes	148
6.2.2 Eukaryotes	151
6.3 Replication	152
6.3.1 Replication initiation	154
6.3.2 Replication elongation	155
6.3.3 Termination of replication	156
6.4 Control of gene expression	158
6.4.1 RNA polymerase binding	159
6.4.2 Transcriptional regulatory proteins	162
6.5 Transcription: the twin supercoiled domain model	165
6.5.1 The role of topoisomerases in transcription	168
6.6 Recombination	169
6.6.1 General recombination	169
6.6.2 Site-specific recombination	170
6.6.2.1 Integrase-type recombination	171
6.6.2.2 Resolvase-type recombination	175
6.7 Conclusions	178
6.8 Further Reading	179
6.9 References	180
Glossary	187
Index	193