

Contents

<i>Introduction to the third edition</i>	<i>page xi</i>
<i>Introduction to the second edition</i>	<i>xii</i>
<i>Introduction to the first edition</i>	<i>xiii</i>
<i>List of abbreviations</i>	<i>xv</i>
1 Deoxyribonucleic acid (DNA)	1
1.1 The genetic material	1
1.2 DNA is a polar helical molecule	1
1.3 DNA molecules are very long but can be twisted into compact forms	5
1.4 Replication of DNA is semi-conservative	8
1.5 The gene or cistron is the functional unit of DNA	9
1.6 Proteins bind to DNA	11
1.7 DNA can be damaged and repaired	14
2 Ribonucleic acid (RNA)	19
2.1 Expression of the information in DNA is mediated by RNA	19
2.2 Transcription is a major stage of gene expression	20
2.3 The four major classes of RNA	21
2.4 The genetic code	28
2.5 RNA editing	30
2.6 Translation is a later stage of gene expression	31
3 Methodology	37
3.1 Preparation of DNA samples for investigation	37

viii Contents

3.2	Vectors used in work with recombinant DNA	39
3.3	Electrophoresis of nucleic acids	41
3.4	Footprinting	42
3.5	Reverse transcriptase	44
3.6	Site-directed mutagenesis	46
3.7	Restriction endonucleases	47
3.8	Reporter genes	50
3.9	Restriction fragment length polymorphisms	51
3.10	Hybridisation of nucleic acids	52
3.11	The determination of base sequence in DNA	54
4	Prokaryotic DNA replication and gene expression	58
4.1	Replication	58
4.2	Transcription	63
4.3	Some RNAs are processed after transcription	67
4.4	Transposable genetic elements	68
5	The operon concept	70
5.1	Genes for sets of metabolically related enzymes are transcribed as one long message	70
5.2	The <i>lac</i> operon	74
5.3	The <i>gal</i> operon	75
5.4	The <i>ara</i> operons	77
5.5	The <i>mal</i> regulon	77
5.6	The <i>trp</i> operon; control by attenuation	78
5.7	Arginine biosynthesis	81
5.8	Ribosomal proteins	82
5.9	The stringent response	84
6	Eukaryotic gene organisation and replication	86
6.1	DNA is in the nucleus in discrete linear chromosomes, associated with proteins	86
6.2	Histones associate in a regular fashion with DNA to form nucleosomes	88
6.3	Eukaryotic replication	90
6.4	Some genes can be amplified	93
7	Eukaryotic transcription	95
7.1	RNA polymerase I transcribes ribosomal RNA genes	95

7.2 RNA polymerase III transcribes the genes of small RNAs	97
7.3 RNA polymerase II transcribes genes encoding proteins and some small RNAs	98
7.4 Transcriptional control	101
7.5 Transcriptional control in yeast	105
7.6 Methylation of some cytosine residues may control transcription	106
7.7 Enhancers	109
8 Post-transcriptional processing of RNA	110
8.1 Termination of transcription	110
8.2 mRNA molecules have a cap added after transcription	112
8.3 The coding sequence of many genes is interrupted by non-coding sequences	113
8.4 Introns are transcribed into mRNA and then removed	116
8.5 Some pre-mRNAs can be spliced in different ways	118
8.6 Self-splicing of introns	120
8.7 Stability of mRNA	121
8.8 Post-translational modifications may be needed to produce functional proteins	122
9 Oncogenes	125
9.1 Retroviruses can be oncogenic, causing cancer	125
9.2 Oncogenes affect the growth of cells	127
9.3 Chromosomal alterations in cancer	130
10 Haemoglobin	133
10.1 Genes for globins are found in two clusters	133
10.2 Thalassaemias	136
10.3 Other mutations	139
10.4 Prenatal diagnosis of anaemias	140
11 Proteins of the immune system	141
11.1 Immunoglobulins consist of H and L chains	141
11.2 The variability of immunoglobulins is due to genomic rearrangements	143
11.3 L chain genes	144
11.4 H chain genes	144
11.5 DNA processing is employed during the course of the immune response	146
11.6 Transcriptional control of Ig genes	148
11.7 Allelic exclusion	149

x **Contents**

11.8	T-cell receptors	150
11.9	The major histocompatibility complex	151
11.10	Class I genes are highly polymorphic	155
11.11	Class II genes	156
11.12	Ig superfamily	156
11.13	Complement genes	157
12	Some gene families	159
12.1	Collagen	159
12.2	Cytochrome P450	160
12.3	Serine hydrolases	162
12.4	Lipoproteins	165
12.5	G-protein-coupled receptors	165
12.6	Growth hormone family	166
12.7	Glycoprotein hormones	167
12.8	Polyproteins are proteolytically processed to yield the active hormones	168
13	Mitochondrial and chloroplast genomes	172
13.1	Yeast mitochondrial genome	172
13.2	Animal mitochondrial genomes	177
13.3	Plant mitochondrial genomes	179
13.4	Chloroplast genomes	180
14	Different and evolving genomes	183
14.1	The structures of prokaryotic and eukaryotic genes are different	183
14.2	Control mechanisms in prokaryotes and eukaryotes	184
14.3	Repeated sequences occur widely in many genomes	187
14.4	The plasticity of the genome	189
14.5	Evolution	190
14.6	Future developments	193
	<i>Glossary</i>	197
	<i>Reading lists</i>	201
	<i>Index</i>	208