

Contents

<i>Preface</i>	v
Chapter 1. The control of gene expression and its levels of action	1
A. Control at the level of transcription	3
1. Elimination or destruction of the gene	3
2. DNA sequences which are normally incapable of transcription	3
3. Control by large scale chromatin condensation	4
4. Control of one sequence by another	5
5. Effects of one gene on its homologue	6
6. Specificity and availability of RNA polymerase enzyme	7
B. Experimental approaches to transcriptional regulation	7
1. Antagonists of transcription	7
2. Molecular hybridization	8
C. Control at a post-transcriptional level	10
1. Attachment of poly A sequences to Hn RNA	10
2. Size reduction of the Hn RNA	10
3. Nuclear screening of RNA transcripts	10
4. Formation of protein mRNA complexes	10
5. Ribosomal translation of mRNA and possible selection	11
6. Messenger RNA lifespan and degradation	11
7. Availability of amino acids and transfer RNA	12
8. Release of the polypeptide chain from the ribosome	12
9. Association of sub-units in polymer proteins	12
10. Post-translation modification of proteins	12
11. Specific storage or degradation of protein	13
D. Experimental approaches to post-transcriptional regulation	13
Chapter 2. Gene expression in prokaryotes	14
A. Genetic organization in prokaryotes	15
B. Transcriptional control	16
C. Bacterial operons (negative control)	17
D. Positive control	19
E. Sequential control of gene expression	21
F. Multiple gene copies	23

G. Recognition of base sequences by tertiary structure	24
H. Post transcriptional control	24
I. Expression of extrachromosomal genetic factors in bacteria	28
J. Comment	29

Chapter 3. Experimental systems of differential gene function in eukaryotes—systems involving one type of protein 30

A. Immunoglobulins	30
1. Gene clustering	30
2. Allelic exclusion	36
3. Preservation of allotypic identity with idiotypic variation	37
4. Somatic mutation	38
5. Translocation	39
6. Cellular control of antibody production	40
7. Comment	41
B. Lactate dehydrogenase	41
1. LDH subunits with very restricted expression	44
2. The distribution of the A and B type LDH subunits	45
3. Different tissues of the adult animal display different LDH patterns	46
4. The same tissue in one animal may display different LDH patterns at different times in ontogeny	51
5. Specific degradation of LDH isoenzymes	51
6. Comment	52
C. Haemoglobin	53
1. Structure and distribution of haemoglobin	54
2. Erythroid cells	59
3. Control of haemoglobin synthesis	63
4. The erythrocytes as a terminally differentiated cell	71
5. Erythrocyte included in fused hybrid cells	71
6. Haemoglobin synthesis by erythroleukaemic cells	73
7. Globin gene frequency in the genome	74
8. Comment	74
D. Lens crystallins	75
1. Regulation of crystallin synthesis	76
2. Ontogenic succession of crystallins	78
3. The differential distribution of crystallins	79
4. Stability of messenger RNA	79
5. Other lens proteins	80
6. Lens regeneration	81
7. Lens fibre differentiation <i>in vitro</i>	81
8. Comment	82
E. Milk proteins	83
1. Hormonal influences on mammary gland differentiation and synthesis	85
2. The insulin effect and cell division	86
3. The specific effect of prolactin	87
4. Genetic variants of milk proteins and mRNA isolation	87

5. Linkage of the milk protein genes	88
6. Comment	88
F. Fibroin	88
1. Polyploidy of the silk glands	89
2. Transcriptional and translation control in fibroin synthesis	90
3. Isolation of fibroin messenger RNA	92
4. Comment	92
G. Cocoonase	93
1. Chemical characteristics of the protein	94
2. Synthesis of the protein	94
3. Comment	97
H. Vertebrate egg proteins	97
1. Egg yolk proteins	98
2. Egg white proteins	100
3. Comment	102

Chapter 4. Experimental systems of differential gene function in eukaryotes—systems of limited complexity 104

A. Pancreas	104
1. Exocrine pancreas	105
2. Endocrine pancreas	107
3. Comment	110
B. Enzyme synthesis during the yeast cell cycle	111
1. Comment	116
C. Muscle	117
1. Structure of skeletal muscle	118
2. The development of skeletal muscle in the embryo	120
3. Muscle cell proteins	122
4. Control of the levels of muscle proteins	127
5. Comment	130
D. <i>Aspergillus</i> and <i>Neurospora</i>	130
1. Genome associated proteins	131
2. Positive control of fungal genes	131
3. Induction by product	133
4. Gene clustering	133
5. Comment	135
E. Nuclear transplantation and microinjection	136
1. Nuclear transfer by micromanipulation	137
2. Nuclear transplantation and labelled molecules	141
3. Cell fusion experiments	141
4. Microinjection of cell contents other than nuclei	145
5. Microinjection of messenger RNA	146
6. Comment	150
F. Cartilage	151
1. Differentiation of cartilage <i>in vitro</i>	153
2. Cartilage differentiation <i>in vivo</i> and in organ transplants	155
3. The effects of BUdR on cartilage differentiation	155
4. Comment	157

G. Liver	158
1. Hormonal control of liver enzymes	161
2. Inducible enzyme synthesis in liver	162
3. Enzyme synthesis in amphibian liver	163
4. α Foetoprotein in liver	164
5. Comment	165
H. DNA—associated proteins	165
1. Histones and other basic proteins	166
2. Histone structure and function	167
3. Histone genes	170
4. Structure of histone in chromatin	172
5. Non-basic proteins	172
6. DNA Polymerase	172
7. RNA Polymerase	174
8. Regulatory non-basic proteins	176
9. Reconstitution of eukaryotic chromatin	181
10. Comment	183
Chapter 5. Experimental systems of differential gene function in eukaryotes—systems not well understood in molecular terms	184
A. The early mammalian embryo	184
1. What determines cell fate in the mammalian embryo?	184
2. Are inner and outer cells different	187
3. Teratomas from embryonic cells	188
4. Comment	190
B. Slime moulds	192
1. The cellular slime moulds	192
2. The plasmodial slime moulds	197
3. Comment	200
C. Protozoa—studies on cortical inheritance	200
1. Cortical inheritance in <i>Paramecium</i> —cortical proteins	200
2. Cortical inheritance in <i>Paramecium</i> and <i>Stentor</i> —cortical pattern	202
3. Comment	205
D. <i>Acetabularia</i>	205
1. Grafting procedure in <i>Acetabularia</i>	208
2. Nuclear transplants	209
3. Biochemical aspects of the <i>Acetabularia</i> experiments	210
4. The autonomy of the chloroplasts	214
5. Comment	214
E. <i>Hydra</i>	215
1. Regeneration in explanted <i>Hydra</i> tissue	217
2. Comment	220
F. The imaginal discs in <i>Drosophila</i>	221
1. The onset of developmental commitment	224
2. Homeotic mutants	226
3. Transdetermination	229
4. Phenocopies	231
5. Specification	231

6. Comment	233
G. Higher Plants	233
1. Growth of plants from isolated somatic cells	234
2. Crown gall in plants	234
3. Phase growth in ivy (<i>Hedera helix</i>)	236
4. Unusual genetic elements in maize and <i>Antirrhinum</i>	238
5. Comment	240
H. Mitochondria and chloroplasts	241
1. The petite mutant in yeast	244
2. Chloroplast genetics in <i>Chlamydomonas</i>	246
3. Comment	248

Chapter 6. RNA involvement in gene expression 250

A. Ribosomal RNA	250
1. Synthesis and processing of RNA	250
2. Function of the ribosome	251
3. Arrangement and expression of genes for ribosomal RNA	252
4. Amplification and magnification of genes for rRNA	255
B. Transfer RNA	257
C. Heterogeneous nuclear RNA	258
D. Messenger RNA	261
1. Characteristics of the molecule	261
2. Synthesis and precursors	262
3. Utilization in the cytoplasm	264

Chapter 7. General concepts of gene regulation 266

A. Chromosome structure and gene masking	266
1. Inactivated blocks of genes	267
2. Repeated DNA sequences	269
3. Controlled transcription of single genes	272
4. The use of BUdR(5-Bromodeoxyuridine)	276
5. Integration of gene expression in differentiation	276
B. Post-transcriptional control and the role of the cytoplasm	279
1. Regulation after translation	280
2. Modification of nuclear gene activity by the cytoplasm	280
3. Cytoplasmic DNA—mitochondria and chloroplasts	281
C. Hormones and other extracellular factors	283
1. Animal hormones	283
2. Plant hormones	286
3. Chalcones	287
4. Phytohaemagglutinin	288

References 289

Additional references 320

Author Index 323

Subject Index 336