

Contents

Preface to the Second Edition ix

Preface to the First Edition xi

1 Heredity 1

GREGOR MENDEL 1 CHROMOSOMES 7 MENDELISM
REDISCOVERED 15 DROSOPHILA 16 CLASSICAL GENETICS 21
THE BIRTH OF MOLECULAR GENETICS 24

2 Cells 31

CELL CHEMISTRY 31 BACTERIA 41
RESTATEMENT OF THE FUNDAMENTAL PROBLEM 58

3 Metabolism 61

FERMENTATION 62 METABOLISM OF SUGARS OTHER THAN GLUCOSE 72
BUILDING-BLOCK SYNTHESIS 75 SUMMARY STATEMENT ON
METABOLISM 84

4 Enzymes 89

ENZYME STRUCTURE 91 ENZYME ACTION 112
CONTROL OF ENZYME ACTIVITY 120

5 Genes 129

THE ENZYME-CANNOT-MAKE-ENZYME PARADOX 130
THE ONE-GENE-ONE-ENZYME THEORY 131 BACTERIAL MUTANTS 136
TEMPERATURE-SENSITIVE MUTANTS 141 PATHWAY ANALYSIS 143
GENE-PROTEIN RELATIONS 149

6 Mutation 152

PLEOMORPHISM, MONOMORPHISM, AND DISSOCIATION 152 ORIGIN OF
PHAGE-RESISTANT VARIANTS 155 DRUG-RESISTANT MUTANTS 169
FORWARD, REVERSE, AND SUPPRESSOR MUTATIONS 174

7 Transformation 180

THE TRANSFORMING PRINCIPLE 180 EFFICIENCY OF
TRANSFORMATION 191 GENE LINKAGE 196

8 DNA Structure and Replication 199

THE EQUIVALENCE RULE 199 THE WATSON-CRICK STRUCTURE 202
DENATURATION OF THE DOUBLE HELIX 209 RENATURATION OF THE
DOUBLE HELIX 213 ADUMBRATION OF THE GENETIC CODE 219
SECOND STATEMENT OF THE BASIC PROBLEM 225 THE WATSON-CRICK DNA
REPLICATION MECHANISM 226 THE MESELSON-STAHLE EXPERIMENT 229
DENSITY DETERMINATIONS 233 REPLICATION ORDER 237
DNA SEGREGATION 243 ENZYMATIC DNA SYNTHESIS 245

9 Conjugation 251

THE CLASSICAL CROSS 251 ONE-WAY TRANSFER AND THE F FERTILITY
FACTOR 257 HIGH-FREQUENCY, OR H^+ , DONOR STRAINS 262
ORIENTED TRANSFER 263 NATURE OF THE $F^+ \times F^-$ CROSS 268
THE CIRCULAR CHROMOSOME 270 THE FERTILITY FACTOR AS
A PLASMID 274 THE CONJUGAL BRIDGE AND MOBILIZATION 280
GENETIC RECOMBINATION IN THE MEROZYGOTE 285

10 Phage Growth 293

VIRUSES 293 TITRATION 296 STRUCTURE AND COMPOSITION 298
ONE-STEP GROWTH 301 THE ECLIPSE 305 THE HERSHEY-CHASE
EXPERIMENT 307 SYNTHESIS OF PHAGE PRECURSORS 312
PHAGE ASSEMBLY 317 PHAGE-INDUCED ENZYMES 322
A MINUTE PHAGE 323

11 Recombination 330

PHAGE MUTANTS 330 THE MAP 338 THE MATING POOL 342
HETEROZYGOTES 345 THE MECHANISM OF RECOMBINATION 349
CORRESPONDENCE BETWEEN GENETIC MAP AND DNA MOLECULE 356 THE
MOLECULAR BASIS OF RECOMBINATION 358 THE ROLE OF NUCLEASES IN
RECOMBINATION 367 INSERTION SEQUENCES 368

12 Genetic Fine Structure 375

RUNNING THE MAP INTO THE GROUND 375 THE CISTRON 382
 MOLECULAR MECHANISM OF MUTATION 390 MUTAGENS 394
 REVERSE MUTATION 400 MUTAGENESIS IN BACTERIA 403
 GENERAL NATURE OF THE GENETIC CODE 405

13 Lysogeny and Transduction 413

LYSOGENIC BACTERIA 413 NATURE OF THE PROPHAGE 418
 CHROMOSOMAL INTEGRATION OF THE PROPHAGE 423 COHESIVE END
 STRUCTURE 426 ZYGOTIC INDUCTION AND THE REPRESSOR 429
 GENETIC CONTROL OF LYSOGENIZATION 430 LYSOGENIC
 CONVERSION 432 RESTRICTED TRANSDUCTION 433 CRYPTIC
 PROPHAGES 439 ILLEGITIMATE RECOMBINATION 441 GENERAL
 TRANSDUCTION 444 ORIGIN OF THE GENERAL TRANSDUCING
 FRAGMENT 447 FINE-STRUCTURE MAPPING 450 COLINEARITY OF
 GENE AND PROTEIN 457

14 DNA Transcription 464

RIBONUCLEIC ACID, OR RNA 464 RIBOSOMES 465
 MESSENGER RNA 470 RNA-DNA HYBRIDIZATION 473
 RNA POLYMERASE 482 INITIATION OF TRANSCRIPTION 487
 TERMINATION OF TRANSCRIPTION 493 RNA POLYMERASE SUBUNITS 494
 RNA CHAIN-GROWTH RATE 496

15 RNA Translation 501

DIRECTION OF POLYPEPTIDE CHAIN GROWTH 501 POLYRIBOSOMES 503
 THE ADAPTOR 510 TRANSFER RNA STRUCTURE 518 AMINO ACID
 ASSEMBLY 526 PEPTIDE CHAIN INITIATION 529 THE RIBOSOME
 CYCLE 531 POST-TRANSLATIONAL CLEAVAGE 535
 MISSENSE SUPPRESSORS 536

16 Genetic Code 540

AMINO ACID REPLACEMENTS 540 ARTIFICIAL MESSENGER RNA 543
 THE CODE TABLE 547 DIRECTION OF THE CODE 550 THE ANTICODON
 AND tRNA 554 NONSENSE CODONS 558 NONSENSE
 SUPPRESSION 566 SUPPRESSION AND ANTISUPPRESSION AT THE
 RIBOSOMAL LEVEL 569 INTERGENIC FRAMESHIFT SUPPRESSORS 571
 EVOLUTION OF THE CODE 572

17 Genetic RNA 575

THE TOBACCO MOSAIC VIRUS 575 INFECTIOUS RNA 580 TWO
 MALE-SPECIFIC PHAGES 582 RNA REPLICATION 587 PHAGE PROTEIN
 SYNTHESIS 593 RNA-PHAGE GENETICS 596 REGULATION OF PHAGE
 PROTEIN SYNTHESIS 597 REVERSE TRANSCRIPTASE 599

18 DNA Replication Mechanism 607

- ORIGIN AND DIRECTION OF REPLICATION OF PHAGE DNA 608
- ORIGIN AND DIRECTION OF REPLICATION OF THE BACTERIAL CHROMOSOME 615
- REGULATION OF INITIATION OF REPLICATION 620
- GENETIC DISSECTION OF THE DNA REPLICATION PROCESS 620
- A NEW DNA POLYMERASE 624
- THE PRIMING OF DNA SYNTHESIS 624
- THE ROLE OF DNA POLYMERASE I IN DNA REPLICATION 627
- NASCENT DNA FRAGMENTS 627

19 DNA Transactions 633

- HOST-CONTROLLED RESTRICTION AND MODIFICATION 633
- DNA TRANSMETHYLATION 637
- ENZYMOLGY OF RESTRICTION AND MODIFICATION 641
- PLASMID ENGINEERING 646
- DNA REPAIR 653
- REPAIR AND RECOMBINATION 659
- UV MUTAGENESIS 661

20 Regulation of Gene Function 667

- ENZYME INDUCTION 668
- GENETIC CONTROL OF ENZYME FORMATION 672
- THE REPRESSOR 673
- OPERATOR AND OPERON 675
- REGULATION OF TRANSCRIPTION 678
- IDENTIFICATION OF REPRESSOR AND OPERATOR 680
- THE PROMOTER 682
- CATABOLITE REPRESSION 683
- ENZYME REPRESSION 690
- THE ATTENUATOR 694
- DIRECT DNA SEQUENCE ANALYSIS 697
- PROPHAGE IMMUNITY AND INDUCTION 701
- CONTROL OF PHAGE REPRESSOR FORMATION 703
- THE LYTIC RESPONSE 706
- THE DECISION BETWEEN LYTIC AND LYSOGENIC RESPONSES 709
- CONTROL OF RIBOSOME SYNTHESIS 710

21 Ramifications 721

- CHROMOSOME STRUCTURE 722
- CHROMOSOME REPLICATION AND RECOMBINATION 725
- CHROMOSOMAL REDUNDANCY 731
- NUCLEAR-CYTOPLASMIC RELATIONS 736
- MITOCHONDRIA 740
- CELL DIFFERENTIATION 742
- IMMUNE RESPONSE 749
- THE BRAIN 755

INDEX 759