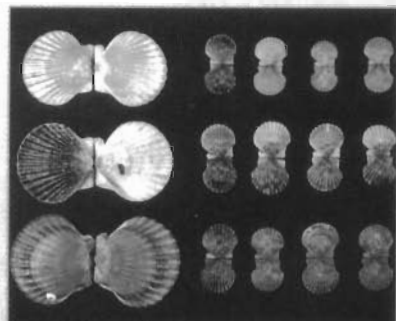
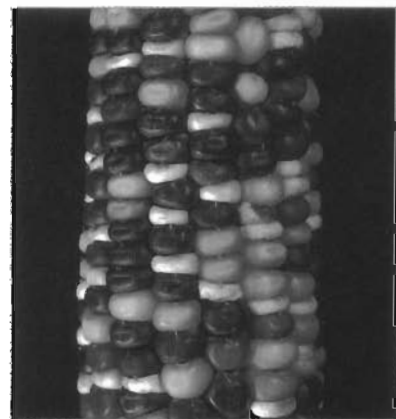


# Contents

<b>PREFACE</b>	xi
<b>GENERAL ASPECTS OF INHERITANCE</b>	
<b>1 GENETICS AND THE ORGANISM</b>	1
Genes as Determinants of the Inherent Properties of Species	3
Genetic Variation	10
Methodologies Used in Genetics	13
Genes, the Environment, and the Organism	15
<b>2 PATTERNS OF INHERITANCE</b>	27
Mendel's Experiments	28
Using Genetic Ratios	37
Sex Chromosomes and Sex-Linked Inheritance	38
Human Genetics	40
<b>3 CHROMOSOMAL BASIS OF HEREDITY</b>	67
Historical Development of the Chromosome Theory	68
Mendelian Genetics in Eukaryotic Life Cycles	76
Topography of the Chromosome Set	85
Three-Dimensional Structure of Chromosomes	89
Sequence Organization	94
<b>4 GENE INTERACTION</b>	105
From Genes to Phenotypes	106
A Diagnostic Test for Alleles	106
Interactions Between the Alleles of One Gene	109
Gene Interaction and Modified Dihybrid Ratios	114
Gene Interaction in Petal Color of Foxgloves	119
Gene Interaction in Coat Color of Mammals	120
Penetrance and Expressivity	124
Chi-Square Test	124
<b>GENETIC MAPPING</b>	
<b>5 BASIC EUKARYOTIC CHROMOSOME MAPPING</b>	141
The Discovery of Linkage	142
Recombination	144
Linkage Symbolism	145
Linkage of Genes on the X Chromosome	146
Linkage Maps	147
Three-Point Testcross	150



Interference	151
Calculating Recombinant Frequencies from Selfed Dihybrids	152
Examples of Linkage Maps	153
Chi-Square Test for Linkage	153
Mapping with Molecular Markers	157
Linkage Mapping by Recombination in Humans	157
Nature of Crossing-Over	160

## 6 SPECIALIZED EUKARYOTIC CHROMOSOME MAPPING TECHNIQUES 175

Accurate Calculation of Large Map Distances	176
Analysis of Single Meioses	179
Mapping Genes by Mitotic Segregation and Recombination	186
Mapping by In Situ Hybridization	190
Mapping Human Genes by Using Human-Rodent Somatic Cell Hybrids	190

## 7 GENE TRANSFER IN BACTERIA AND THEIR VIRUSES 207

Working with Microorganisms	208
Bacterial Conjugation	209
Bacterial Transformation	219
Bacteriophage Genetics	220
Transduction	225
Chromosome Mapping	230
Bacterial Gene Transfer in Review	231

## MOLECULAR GENETICS

### 8 THE STRUCTURE AND REPLICATION OF DNA 241

DNA: The Genetic Material	242
Structure of DNA	243
Replication of DNA	249
Mechanism of DNA Replication	253

### 9 GENETICS OF DNA FUNCTION 267

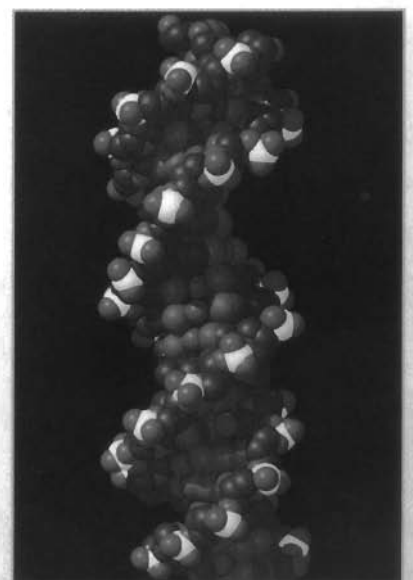
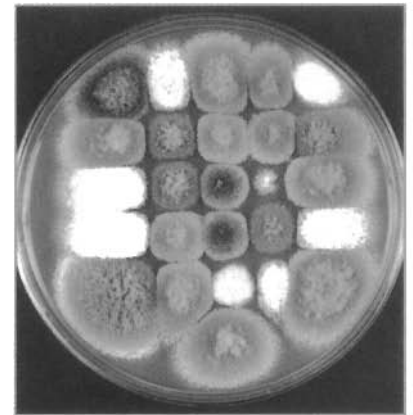
How Genes Work	268
Gene-Protein Relations	271
Genetic Fine Structure	283
Mutational Sites	285
Complementation	287

### 10 MOLECULAR BIOLOGY OF GENE FUNCTION 299

Properties of RNA	300
Transcription	300
Transcription and RNA Polymerase	303
Eukaryotic RNA	306
Translation	312
Genetic Code	312
Protein Synthesis	320
Universality of Genetic Information Transfer	325
Functional Division of Labor in the Gene Set	328

### 11 REGULATION OF GENE TRANSCRIPTION 335

Basic Control Circuits	336
Discovery of the <i>lac</i> System: Negative Control	337



Catabolite Repression of the <i>lac</i> Operon: Positive Control	342
Positive and Negative Control	344
Dual Positive and Negative Control: The Arabinose Operon	344
Metabolic Pathways	345
Additional Examples of Control: Attenuation	345
Lambda Phage: A Complex of Operons	348
Transcription: An Overview of Gene Regulation in Eukaryotes	350
Regulation of Transcription Factors	357
Epigenetic Inheritance	359

## 12 RECOMBINANT DNA TECHNOLOGY 365

Making Recombinant DNA	366
Cloning a Specific Gene	372
Using Cloned DNA	384

## 13 APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 403

In Vitro Mutagenesis	404
RFLP Mapping	404
Reverse Genetics	407
Expressing Eukaryotic Genes in Bacteria	408
Recombinant DNA Technology in Eukaryotes	409
Gene Therapy	422
Using Recombinant DNA to Detect Disease Alleles Directly	425

## 14 GENOMICS 435

Genomics: An Overview	436
Genome Projects: Practical Considerations	436
Structural Genomics	437
Functional Genomics	452

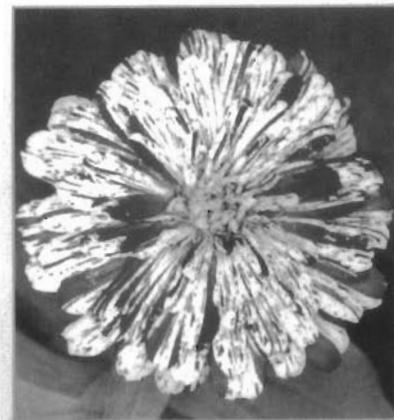
## GENERATION OF GENETIC VARIATION

### 15 GENE MUTATION 463

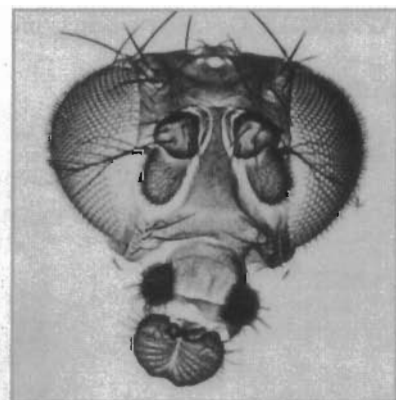
How DNA Changes Affect Phenotype	465
Somatic Versus Germinal Mutation	467
Mutant Types	470
Occurrence of Mutations	472
Selective Systems	477
Mutation Induction	482
Mutation and Cancer	484
Mutagens in Genetic Dissection	484
Mutation Breeding	486

### 16 MECHANISMS OF GENE MUTATION 495

Molecular Basis of Gene Mutations	496
Spontaneous Mutations	496
Induced Mutations	502
Reversion Analysis	508
Relation Between Mutagens and Carcinogens	508
Biological Repair Mechanisms	510
Repair Defects and Human Diseases	516



<b>17</b>	<b>CHROMOSOME MUTATION I: CHANGES IN CHROMOSOME STRUCTURE</b>	<b>523</b>
	Origin of Changes in Chromosome Structure	524
	Deletions	525
	Duplications	529
	Inversions	532
	Translocations	536
	Diagnosis of Rearrangements by Tetrad Analysis	541
<b>18</b>	<b>CHROMOSOME MUTATION II: CHANGES IN CHROMOSOME NUMBER</b>	<b>555</b>
	Aberrant Euploidy	556
	Aneuploidy	564
	Mechanisms of Gene Imbalance	572
	Chromosome Mechanics in Plant Breeding	575
<b>19</b>	<b>MECHANISMS OF RECOMBINATION</b>	<b>585</b>
	Breakage and Reunion of DNA Molecules	586
	Chiasmata: The Crossover Points	587
	Genetic Results Leading to Recombination Models	587
	Holliday Model	588
	Enzymatic Mechanism of Recombination	592
<b>20</b>	<b>TRANSPOSABLE GENETIC ELEMENTS</b>	<b>601</b>
	Controlling Elements in Maize	602
	Bacterial Insertion Sequences	605
	Prokaryotic Transposons	607
	Mechanism of Transposition in Prokaryotes	610
	Review of Transposable Elements in Prokaryotes	614
	Molecular Nature of Transposable Elements in Eukaryotes	614
	Review of Transposable Elements in Eukaryotes	619
<b>DEVELOPMENT</b>		
<b>21</b>	<b>EXTRANUCLEAR GENES</b>	<b>623</b>
	Origin of Extranuclear Genes	624
	Structure of Organelle Chromosomes	624
	Organelle Mutations	629
	Inheritance of Organelle Genes and Mutations	630
	Recombination of Extranuclear DNA	636
	Cytoplasmic Male Sterility	637
	Mitochondria and Aging	637
<b>22</b>	<b>CANCER AS A GENETIC DISEASE</b>	<b>647</b>
	Cancer and the Control of Cell Number: An Overview	648
	Cell Proliferation Machinery	648
	Machinery for Programmed Cell Death	652
	Controlling the Cell-Proliferation and Death Machinery	654
	Cancer: The Genetics of Aberrant Cell Control	659
	Cancer Research in the Genomic Analysis Era	666
<b>23</b>	<b>DEVELOPMENTAL GENETICS</b>	<b>671</b>
	Central Themes of Developmental Genetics	672
	Gene Regulation at Levels Other Than Transcription	
	Initiation: Examples	674



Binary Fate Decisions: Pathways of Sex Determination	676
<i>Drosophila</i> Sex Determination: Every Cell for Itself	677
Sex Determination in Mammals: Coordinated Control by the Endocrine System	681
Binary Fate Decisions: The Germ Line versus the Soma	684
Forming Complex Pattern: Establishing Positional Information	688
Forming Complex Pattern: Utilizing Positional Information to Establish Cell Fates	694
Additional Aspects of Pattern Formation	700
The Many Parallels in Vertebrate and Insect Pattern Formation	704
Do the Lessons of Animal Development Apply to Plants?	706

**GENES AT THE POPULATION LEVEL**

<b>24 POPULATION GENETICS</b>	<b>713</b>
Variation and Its Modulation	714
Effect of Sexual Reproduction on Variation	721
Sources of Variation	723
Selection	728
Balanced Polymorphism	732
Artificial Selection	734
Random Events	735

<b>25 QUANTITATIVE GENETICS</b>	<b>743</b>
Some Basic Statistical Notions	745
Genotypes and Phenotypic Distribution	746
Norm of Reaction and Phenotypic Distribution	748
Determining Norms of Reaction	750
Heritability of a Trait	752
Quantifying Heritability	754
Locating the Genes	757
More on Analyzing Variance	760

<b>26 EVOLUTIONARY GENETICS</b>	<b>773</b>
A Synthesis of Forces: Variation and Divergence of Populations	775
Multiple Adaptive Peaks	779
Heritability of Variation	781
Observed Variation Within and Between Populations	782
Process of Speciation	783
Origin of New Genes	785
Rate of Molecular Evolution	789

<b>APPENDIX Genetic Nomenclature</b>	<b>797</b>
--------------------------------------	------------

<b>FURTHER READINGS</b>	<b>799</b>
-------------------------	------------

<b>GLOSSARY</b>	<b>807</b>
-----------------	------------

<b>ANSWERS TO SELECTED PROBLEMS</b>	<b>829</b>
-------------------------------------	------------

<b>INDEX</b>	<b>847</b>
--------------	------------

