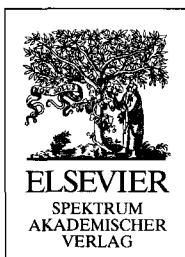


David P. Clark  
*Southern Illinois University*

# Molecular Biology Das Original mit Übersetzungshilfen

*Understanding the Genetic  
Revolution*

Übersetzung: Andreas und Manuela Held



**Spektrum**  
AKADEMISCHER VERLAG

# Detailed Contents

<b>CHAPTER 1 <i>Basic Genetics</i></b>	<b>1</b>	Some Widely Studied Organisms Serve as Models	40
Gregor Mendel Was the Father of Classical Genetics	2	Yeast Is a Widely Studied Single-Celled Eukaryote	40
Genes Determine Each Step in Biochemical Pathways	3	A Roundworm and a Fly are Model Multicellular Animals	41
Mutants Result from Alterations in Genes Phenotypes and Genotypes	4	Zebrafish are used to Study Vertebrate Development	42
Chromosomes Are Long, Thin Molecules That Carry Genes	6	Mouse and Man	44
Different Organisms may Have Different Numbers of Chromosomes	7	<i>Arabidopsis</i> Serves as a Model for Plants	44
Dominant and Recessive Alleles	8	Haploidy, Diploidy and the Eukaryote Cell Cycle	45
Partial Dominance, Co-Dominance, Penetrance and Modifier Genes	9	Viruses Are Not Living Cells	46
Genes from Both Parents Are Mixed by Sexual Reproduction	11	Bacterial Viruses Infect Bacteria	47
Sex Determination and Sex-Linked Characteristics	13	Human Viral Diseases Are Common	48
Neighboring Genes Are Linked during Inheritance	15	A Variety of Subcellular Genetic Entities Exist	49
Recombination during Meiosis Ensures Genetic Diversity	16		
<i>Escherichia coli</i> Is a Model for Bacterial Genetics	17		
<b>CHAPTER 2 <i>Cells and Organisms</i></b>	<b>21</b>	<b>CHAPTER 3 <i>DNA, RNA and Protein</i></b>	<b>51</b>
What Is Life?	22	Nucleic Acid Molecules Carry Genetic Information	52
Living Creatures Are Made of Cells	23	Chemical Structure of Nucleic Acids	52
Essential Properties of a Living Cell	23	DNA and RNA Each Have Four Bases	54
Prokaryotic Cells Lack a Nucleus	27	Nucleosides Are Bases Plus Sugars; Nucleotides Are Nucleosides Plus Phosphate	55
Eubacteria and Archaeobacteria Are Genetically Distinct	28	Double Stranded DNA Forms a Double Helix	56
Bacteria Were Used for Fundamental Studies of Cell Function	29	Base Pairs are Held Together by Hydrogen Bonds	57
<i>Escherichia coli</i> ( <i>E. coli</i> ) Is a Model Bacterium	31	Complementary Strands Reveal the Secret of Heredity	59
Where Are Bacteria Found in Nature?	32	Constituents of Chromosomes	60
Some Bacteria Cause Infectious Disease, but Most Are Beneficial	34	The Central Dogma Outlines the Flow of Genetic Information	63
Eukaryotic Cells Are Sub-Divided into Compartments	34	Ribosomes Read the Genetic Code	65
The Diversity of Eukaryotes	36	The Genetic Code Dictates the Amino Acid Sequence of Proteins	67
Eukaryotes Possess Two Basic Cell Lineages	36	Various Classes of RNA Have Different Functions	69
Organisms Are Classified	38	Proteins, Made of Amino Acids, Carry Out Many Cell Functions	70
		The Structure of Proteins Has Four Levels of Organization	71
		Proteins Vary in Their Biological Roles	73

<b>CHAPTER 4 <i>Genes, Genomes and DNA</i></b>	<b>75</b>		
History of DNA as the Genetic Material	76	Chromosome Replication Initiates at <i>oriC</i>	118
How Much Genetic Information Is Necessary to Maintain Life?	78	DNA Methylation and Attachment to the Membrane Control Initiation of Replication	120
Non-Coding DNA	78	Chromosome Replication Terminates at <i>terC</i>	121
Coding DNA May Be Present within Non-coding DNA	80	Disentangling the Daughter Chromosomes	122
Repeated Sequences Are a Feature of DNA in Higher Organisms	81	Cell Division in Bacteria Occurs after Replication of Chromosomes	124
Satellite DNA Is Non-coding DNA in the Form of Tandem Repeats	83	How Long Does It Take for Bacteria to Replicate?	124
Minisatellites and VNTRs	84	The Concept of the Replicon	125
Origin of Selfish DNA and Junk DNA	84	Replicating Linear DNA in Eukaryotes	126
Palindromes, Inverted Repeats and Stem and Loop Structures	86	Eukaryotic Chromosomes Have Multiple Origins	129
Multiple A-Tracts Cause DNA to Bend	87	Synthesis of Eukaryotic DNA	130
Supercoiling is Necessary for Packaging of Bacterial DNA	88	Cell Division in Higher Organisms	130
Topoisomerases and DNA Gyrase	89		
Catenated and Knotted DNA Must Be Corrected	91	<b>CHAPTER 6 <i>Transcription of Genes</i></b>	<b>132</b>
Local Supercoiling	91	Genes are Expressed by Making RNA	133
Supercoiling Affects DNA Structure	91	Short Segments of the Chromosome Are Turned into Messages	134
Alternative Helical Structures of DNA Occur	92	Terminology: Cistrons, Coding Sequences and Open Reading Frames	134
Histones Package DNA in Eukaryotes	95	How Is the Beginning of a Gene Recognized?	135
Further Levels of DNA Packaging in Eukaryotes	96	Manufacturing the Message	137
Melting Separates DNA Strands; Cooling Anneals Them	100	RNA Polymerase Knows Where to Stop	138
		How Does the Cell Know Which Genes to Turn On?	140
		What Activates the Activator?	141
		Negative Regulation Results from the Action of Repressors	143
		Many Regulator Proteins Bind Small Molecules and Change Shape	144
		Transcription in Eukaryotes Is More Complex	145
		Transcription of rRNA and tRNA in Eukaryotes	146
		Transcription of Protein-Encoding Genes in Eukaryotes	148
		Upstream Elements Increase the Efficiency of RNA Polymerase II Binding	151
		Enhancers Control Transcription at a Distance	152
<b>CHAPTER 5 <i>Cell Division and DNA Replication</i></b>	<b>103</b>		
Cell Division and Reproduction Are Not Always Identical	104	<b>CHAPTER 7 <i>Protein Structure and Function</i></b>	<b>154</b>
DNA Replication Is a Two-Stage Process Occurring at the Replication Fork	104	Proteins Are Formed from Amino Acids	155
Supercoiling Causes Problems for Replication	105	Formation of Polypeptide Chains	155
Strand Separation Precedes DNA Synthesis	107	Twenty Amino Acids Form Biological Polypeptides	155
Properties of DNA Polymerase	107	Amino Acids Show Asymmetry around the Alpha-carbon	158
Polymerization of Nucleotides	109		
Supplying the Precursors for DNA Synthesis	109		
DNA Polymerase Elongates DNA Strands	111		
The Complete Replication Fork Is Complex	112		
Discontinuous Synthesis of DNA Requires a Primosome	114		
Completing the Lagging Strand	116		

The Structure of Proteins Reflects Four Levels of Organization	160	Charging the tRNA with the Amino Acid	204
The Secondary Structure of Proteins Relies on Hydrogen Bonds	160	The Ribosome: The Cell's Decoding Machine	204
The Tertiary Structure of Proteins	163	Three Possible Reading Frames Exist	208
A Variety of Forces Maintain the 3-D Structure of Proteins	165	The Start Codon Is Chosen	210
Cysteine Forms Disulfide Bonds	166	The Initiation Complexes Must Be Assembled	211
Multiple Folding Domains in Larger Proteins	166	The tRNA Occupies Three Sites During Elongation of the Polypeptide	211
Quaternary Structure of Proteins	167	Termination of Protein Synthesis Requires Release Factors	213
Higher Level Assemblies and Self-Assembly	169	Several Ribosomes Usually Read the Same Message at Once	214
Cofactors and Metal Ions Are Often Associated with Proteins	169	Bacterial Messenger RNA Can Code for Several Proteins	215
Nucleoproteins, Lipoproteins and Glycoproteins Are Conjugated Proteins	172	Transcription and Translation Are Coupled in Bacteria	216
Proteins Serve Numerous Cellular Functions	174	Some Ribosomes Become Stalled and Are Rescued	217
Protein Machines	177	Differences between Eukaryotic and Prokaryotic Protein Synthesis	218
Enzymes Catalyze Metabolic Reactions	177	Initiation of Protein Synthesis in Eukaryotes	218
Enzymes Have Varying Specificities	179	Protein Synthesis Is Halted When Resources Are Scarce	221
Lock and Key and Induced Fit Models Describe Substrate Binding	181	A Signal Sequence Marks a Protein for Export from the Cell	221
Enzymes Are Named and Classified According to the Substrate	181	Molecular Chaperones Oversee Protein Folding	224
Enzymes Act by Lowering the Energy of Activation	182	Protein Synthesis Occurs in Mitochondria and Chloroplasts	225
The Rate of Enzyme Reactions	184	Proteins Are Imported into Mitochondria and Chloroplasts by Translocases	226
Substrate Analogs and Enzyme Inhibitors Act at the Active Site	184	Mistranslation Usually Results in Mistakes in Protein Synthesis	226
Enzymes May Be Directly Regulated	187	The Genetic Code Is Not "Universal"	227
Allosteric Enzymes Are Affected by Signal Molecules	187	Unusual Amino Acids are Made in Proteins by Post-Translational Modifications	227
Enzymes May Be Controlled by Chemical Modification	189	Selenocysteine: The 21st Amino Acid	227
Binding of Proteins to DNA Occurs in Several Different Ways	190	Pyrrolysine: The 22nd Amino Acid	228
Denaturation of Proteins	194	Many Antibiotics Work by Inhibiting Protein Synthesis	230
		Degradation of Proteins	231
<b>CHAPTER 8 Protein Synthesis</b>	<b>197</b>		
Protein Synthesis Follows a Plan	198	<b>CHAPTER 9 Regulation of Transcription in Prokaryotes</b>	<b>234</b>
Proteins Are Gene Products	198	Gene Regulation Ensures a Physiological Response	235
Decoding the Genetic Code	199	Regulation at the Level of Transcription Involves Several Steps	236
Transfer RNA Forms a Flat Cloverleaf Shape and a Folded "L" Shape	200		
Modified Bases Are Present in Transfer RNA	201		
Some tRNA Molecules Read More Than One Codon	202		

Alternative Sigma Factors in Prokaryotes Recognize Different Sets of Genes	238	Genetic Imprinting in Eukaryotes Has Its Basis in DNA Methylation Patterns	275
Heat Shock Sigma Factors in Prokaryotes Are Regulated by Temperature	238	X-chromosome Inactivation Occurs in Female XX Animals	277
Cascades of Alternative Sigma Factors Occur in <i>Bacillus</i> Spore Formation	239		
Anti-sigma Factors Inactivate Sigma; Anti-anti-sigma Factors Free It to Act	242	<b>CHAPTER 11 Regulation at the RNA Level</b>	<b>281</b>
Activators and Repressors Participate in Positive and Negative Regulation	243	Regulation at the Level of RNA	282
The Operon Model of Gene Regulation	244	Binding of Proteins to mRNA Controls The Rate of Degradation	282
Some Proteins May Act as Both Repressors and Activators	246	Some mRNA Molecules Must Be Cleaved Before Translation	283
Nature of the Signal Molecule	248	Some Regulatory Proteins May Cause Translational Repression	284
Activators and Repressors May Be Covalently Modified	252	Some Regulatory Proteins Can Activate Translation	287
Two-Component Regulatory Systems	253	Translation May Be Regulated by Antisense RNA	288
Phosphorelay Systems	254	Regulation of Translation by Alterations to the Ribosome	290
Specific Versus Global Control	254	RNA Interference (RNAi)	291
Crp Protein Is an Example of a Global Control Protein	255	Amplification and Spread of RNAi	292
Accessory Factors and Nucleoid Binding Proteins	256	Experimental Administration of siRNA	293
Action at a Distance and DNA Looping	257	PTGS in Plants and Quelling in Fungi	294
Anti-termination as a Control Mechanism	258	Micro RNA—A Class of Small Regulatory RNA	295
		Premature Termination Causes Attenuation of RNA Transcription	297
<b>CHAPTER 10 Regulation of Transcription in Eukaryotes</b>	<b>262</b>	Riboswitches—RNA Acting Directly as a Control Mechanism	299
Transcriptional Regulation in Eukaryotes Is More Complex Than in Prokaryotes	263		
Specific Transcription Factors Regulate Protein Encoding Genes	264	<b>CHAPTER 12 Processing of RNA</b>	<b>302</b>
The Mediator Complex Transmits Information to RNA Polymerase	264	RNA is Processed in Several Ways	303
Enhancers and Insulator Sequences Segregate DNA Functionally	265	Coding and Non-Coding RNA	304
Matrix Attachment Regions Allow DNA Looping	268	Processing of Ribosomal and Transfer RNA	305
Negative Regulation of Transcription Occurs in Eukaryotes	269	Eukaryotic Messenger RNA Contains a Cap and Tail	305
Heterochromatin Causes Difficulty for Access to DNA in Eukaryotes	270	Capping is the First Step in Maturation of mRNA	306
Methylation of DNA in Eukaryotes Controls Gene Expression	273	A Poly(A) Tail is Added to Eukaryotic mRNA	308
Silencing of Genes Is Caused by DNA Methylation	275	Introns are Removed from RNA by Splicing	310
		Different Classes of Intron Show Different Splicing Mechanisms	314
		Alternative Splicing Produces Multiple Forms of RNA	315

Inteins and Protein Splicing	318
Base Modification of rRNA Requires Guide RNA	322
RNA Editing Involves Altering the Base Sequence	324
Transport of RNA out of the Nucleus	327
Degradation of mRNA	327
Nonsense Mediated Decay of mRNA	328

### **CHAPTER 13 Mutations** **333**

Mutations Alter the DNA Sequence	334
The Major Types of Mutation	335
Base Substitution Mutations	336
Missense Mutations May Have Major or Minor Effects	336
Nonsense Mutations Cause Premature Polypeptide Chain Termination	338
Deletion Mutations Result in Shortened or Absent Proteins	340
Insertion Mutations Commonly Disrupt Existing Genes	341
Frameshift Mutations Sometimes Produce Abnormal Proteins	343
DNA Rearrangements Include Inversions, Translocations, and Duplications	343
Phase Variation Is Due to Reversible DNA Alterations	345
Silent Mutations Do Not Alter the Phenotype	346
Chemical Mutagens Damage DNA	348
Radiation Causes Mutations	350
Spontaneous Mutations Can Be Caused by DNA Polymerase Errors	351
Mutations Can Result from Mismatching and Recombination	353
Spontaneous Mutation Can Be the Result of Tautomerization	353
Spontaneous Mutation Can Be Caused by Inherent Chemical Instability	353
Mutations Occur More Frequently at Hot Spots	355
How Often Do Mutations Occur?	358
Reversions Are Genetic Alterations That Change the Phenotype Back to Wild-type	359
Reversion Can Occur by Compensatory Changes in Other Genes	361
Altered Decoding by Transfer RNA May Cause Suppression	362
Mutagenic Chemicals Can Be Detected by Reversion	363

Experimental Isolation of Mutations	364
<i>In Vivo</i> versus <i>In Vitro</i> Mutagenesis	365
Site-Directed Mutagenesis	366

### **CHAPTER 14 Recombination and Repair** **368**

Overview of Recombination	369
Molecular Basis of Homologous Recombination	370
Single-Strand Invasion and Chi Sites	371
Site-Specific Recombination	373
Recombination in Higher Organisms	376
Overview of DNA Repair	378
DNA Mismatch Repair System	379
General Excision Repair System	381
DNA Repair by Excision of Specific Bases	383
Specialized DNA Repair Mechanisms	384
Photoreactivation Cleaves Thymine Dimers	387
Transcriptional Coupling of Repair	387
Repair by Recombination	388
SOS Error Prone Repair in Bacteria	388
Repair in Eukaryotes	391
Double-Strand Repair in Eukaryotes	392
Gene Conversion	392

### **CHAPTER 15 Mobile DNA** **396**

Sub-Cellular Genetic Elements as Gene Creators	397
Most Mobile DNA Consists of Transposable Elements	397
The Essential Parts of a Transposon	398
Insertion Sequences—the Simplest Transposons	400
Movement by Conservative Transposition	401
Complex Transposons Move by Replicative Transposition	402
Replicative and Conservative Transposition are Related	406
Composite Transposons	406
Transposition may Rearrange Host DNA	408
Transposons in Higher Life Forms	410
Retro-Elements Make an RNA Copy	412
Repetitive DNA of Mammals	414
Retro-Insertion of Host-Derived DNA	415
Retrons Encode Bacterial Reverse Transcriptase	416
The Multitude of Transposable Elements	417

Bacteriophage Mu is a Transposon	417	DNA Viruses of Higher Organisms	466
Conjugative Transposons	420	Viruses with RNA Genomes Have Very Few Genes	467
Integrans Collect Genes for Transposons	420	Bacterial RNA Viruses	469
Junk DNA and Selfish DNA	422	Double Stranded RNA Viruses of Animals	469
Homing Introns	423	Positive-Stranded RNA Viruses Make Polypeptides	469
<b>CHAPTER 16 <i>Plasmids</i></b>	<b>425</b>	Strategy of Negative-Strand RNA Viruses	470
Plasmids as Replicons	426	Plant RNA Viruses	470
General Properties of Plasmids	427	Retroviruses Use both RNA and DNA	472
Plasmid Families and Incompatibility	428	Genome of the Retrovirus	477
Occasional Plasmids are Linear or Made of RNA	428	Subviral Infectious Agents	477
Plasmid DNA Replicates by Two Alternative Methods	430	Satellite Viruses	479
Control of Copy Number by Antisense RNA	432	Viroids are Naked Molecules of Infectious RNA	480
Plasmid Addiction and Host Killing Functions	435	Prions are Infectious Proteins	481
Many Plasmids Help their Host Cells	436	<b>CHAPTER 18 <i>Bacterial Genetics</i></b>	<b>484</b>
Antibiotic Resistance Plasmids	436	Reproduction versus Gene Transfer	485
Mechanism of Antibiotic Resistance	438	Fate of the Incoming DNA after Uptake	485
Resistance to Beta-Lactam Antibiotics	438	Transformation is Gene Transfer by Naked DNA	487
Resistance to Chloramphenicol	439	Transformation as Proof that DNA is the Genetic Material	488
Resistance to Aminoglycosides	440	Transformation in Nature	491
Resistance to Tetracycline	441	Gene Transfer by Virus—Transduction	493
Resistance to Sulfonamides and Trimethoprim	442	Generalized Transduction	493
Plasmids may Provide Aggressive Characters	442	Specialized Transduction	494
Most Colicins Kill by One of Two Different Mechanisms	444	Transfer of Plasmids between Bacteria	495
Bacteria are Immune to their own Colicins	445	Transfer of Chromosomal Genes Requires Plasmid Integration	496
Colicin Synthesis and Release	446	Gene Transfer among Gram-Positive Bacteria	501
Virulence Plasmids	446	Archaeobacterial Genetics	504
Ti-Plasmids are Transferred from Bacteria to Plants	447	Whole Genome Sequencing	506
The 2 Micron Plasmid of Yeast	450	<b>CHAPTER 19 <i>Diversity of Lower Eukaryotes</i></b>	<b>508</b>
Certain DNA Molecules may Behave as Viruses or Plasmids	451	Origin of the Eukaryotes by Symbiosis	509
<b>CHAPTER 17 <i>Viruses</i></b>	<b>453</b>	The Genomes of Mitochondria and Chloroplasts	510
Viruses are Infectious Packages of Genetic Information	454	Primary and Secondary Endosymbiosis	511
Life Cycle of a Virus	455	Is Malaria Really a Plant?	512
Bacterial Viruses are Known as Bacteriophage	458	Symbiosis: Parasitism versus Mutualism	515
Lysogeny or Latency by Integration	460	Bacterial Endosymbionts of Killer <i>Paramecium</i>	515
The Great Diversity of Viruses	462	Is <i>Buchnera</i> an Organelle or a Bacterium?	517
Small Single-Stranded DNA Viruses of Bacteria	463	Ciliates have Two Types of Nucleus	517
Complex Bacterial Viruses with Double Stranded DNA	465	Trypanosomes Vary Surface Proteins to Outwit the Immune System	520

Mating Type Determination in Yeast	525	Chemical Synthesis of DNA	574
Multi-Cellular Organisms and Homeobox Genes	530	Chemical Synthesis of Complete Genes	580
		Peptide Nucleic Acid	580
<b>CHAPTER 20 <i>Molecular Evolution</i></b>	<b>533</b>	Measuring the Concentration DNA and RNA with Ultraviolet Light	582
Getting Started—Formation of the Earth	534	Radioactive Labeling of Nucleic Acids	583
The Early Atmosphere	534	Detection of Radio-Labeled DNA	583
Oparin's Theory of the Origin of Life	535	Fluorescence in the Detection of DNA and RNA	585
The Miller Experiment	536	Chemical Tagging with Biotin or Digoxigenin	587
Polymerization of Monomers to Give Macromolecules	538	The Electron Microscope	588
Enzyme Activities of Random Proteinoids	539	Hybridization of DNA and RNA	590
Origin of Informational Macromolecules	540	Southern, Northern, and Western Blotting	592
Ribozymes and the RNA World	540	Zoo Blotting	595
The First Cells	542	Fluorescence in Situ Hybridization (FISH)	595
The Autotrophic Theory of the Origin of Metabolism	544	Molecular Beacons	598
Evolution of DNA, RNA and Protein Sequences	545		
Creating New Genes by Duplication	547	<b>CHAPTER 22 <i>Recombinant DNA Technology</i></b>	<b>599</b>
Paralogous and Orthologous Sequences	549	Introduction	600
Creating New Genes by Shuffling	550	Nucleases Cut Nucleic Acids	600
Different Proteins Evolve at Very Different Rates	550	Restriction and Modification of DNA	600
Molecular Clocks to Track Evolution	552	Recognition of DNA by Restriction Endonucleases	601
Ribosomal RNA—A Slowly Ticking Clock	552	Naming of Restriction Enzymes	601
The Archaeobacteria versus the Eubacteria	554	Cutting of DNA by Restriction Enzymes	602
DNA Sequencing and Biological Classification	555	DNA Fragments are Joined by DNA Ligase	603
Mitochondrial DNA—A Rapidly Ticking Clock	559	Making a Restriction Map	604
The African Eve Hypothesis	560	Restriction Fragment Length Polymorphisms	607
Ancient DNA from Extinct Animals	562	Properties of Cloning Vectors	608
Evolving Sideways: Horizontal Gene Transfer	564	Multicopy Plasmid Vectors	610
Problems in Estimating Horizontal Gene Transfer	565	Inserting Genes into Vectors	610
		Detecting Insertions in Vectors	612
		Moving Genes between Organisms: Shuttle Vectors	615
<b>CHAPTER 21 <i>Nucleic Acids: Isolation, Purification, Detection, and Hybridization</i></b>	<b>567</b>	Bacteriophage Lambda Vectors	616
Isolation of DNA	568	Cosmid Vectors	617
Purification of DNA	568	Yeast Artificial Chromosomes	620
Removal of Unwanted RNA	569	Bacterial and P1 Artificial Chromosomes	620
Gel Electrophoresis of DNA	570	A DNA Library Is a Collection of Genes from One organism	621
Pulsed Field Gel Electrophoresis	572	Screening a Library by Hybridization	623
Denaturing Gradient Gel Electrophoresis	573	Screening a Library by Immunological Procedures	623
		Cloning Complementary DNA Avoids Introns	624
		Chromosome Walking	626



Cloning by Subtractive Hybridization	628	Mapping of Sequence Tagged Sites	677
Expression Vectors	631	Assembling Small Genomes by Shotgun Sequencing	680
<b>CHAPTER 23 <i>The Polymerase Chain Reaction</i></b>	<b>634</b>	Race for the Human Genome	680
<hr/>		Assembling a Genome from Large Cloned Contigs	683
Fundamentals of the Polymerase Chain Reaction	635	Assembling a Genome by Directed Shotgun Sequencing	683
Cycling Through the PCR	638	Survey of the Human Genome	683
Degenerate Primers	640	Sequence Polymorphisms: SSLPs and SNPs	686
Inverse PCR	641	Gene Identification by Exon Trapping	688
Adding Artificial Restriction Sites	642	Bioinformatics and Computer Analysis	690
TA Cloning by PCR	643	<b>CHAPTER 25 <i>Analysis of Gene Expression</i></b>	<b>693</b>
Randomly Amplified Polymorphic DNA (RAPD)	643	<hr/>	
Reverse Transcriptase PCR	646	Introduction	694
Differential Display PCR	647	Monitoring Gene Expression	694
Rapid Amplification of cDNA Ends (RACE)	649	Reporter Genes for Monitoring Gene Expression	694
PCR in Genetic Engineering	649	Easily Assayable Enzymes as Reporters	696
Directed Mutagenesis	651	Light Emission by Luciferase as a Reporter System	696
Engineering Deletions and Insertions by PCR	651	Green Fluorescent Protein as a Reporter	699
Use of PCR in Medical Diagnosis	652	Gene Fusions	699
Environmental Analysis by PCR	653	Deletion Analysis of the Upstream Region	702
Rescuing DNA from Extinct Life Forms by PCR	654	Locating Protein Binding Sites in the Upstream Region	702
Realtime Fluorescent PCR	655	Location of the Start of Transcription by Primer Extension	706
Inclusion of Molecular Beacons in PCR—Scorpion Primers	656	Location of the Start of Transcription by S1 Nuclease	707
Rolling Circle Amplification Technology (RCAT)	657	Transcriptome Analysis	709
<b>CHAPTER 24 <i>Genomics and DNA Sequencing</i></b>	<b>662</b>	DNA Microarrays for Gene Expression	709
<hr/>		Serial Analysis of Gene Expression (SAGE)	713
Introduction to Genomics	663	<b>CHAPTER 26 <i>Proteomics: The Global Analysis of Proteins</i></b>	<b>717</b>
DNA Sequencing—General Principle	663	<hr/>	
The Chain Termination Method for Sequencing DNA	663	Introduction to Proteomics	718
DNA Polymerases for Sequencing DNA	668	Gel Electrophoresis of Proteins	719
Producing Template DNA for Sequencing	668	Two Dimensional PAGE of Proteins	720
Primer Walking along a Strand of DNA	670	Western Blotting of Proteins	722
Automated Sequencing	670	Mass Spectrometry for Protein Identification	722
The Emergence of DNA Chip Technology	672	Protein Tagging Systems	726
The Oligonucleotide Array Detector	672	Full-Length Proteins Used as Fusion Tags	726
Pyrosequencing	674	Self-Cleavable Intein Tags	729
Nanopore Detectors for DNA	676		
Large Scale Mapping with Sequence Tags	676		

Selection by Phage Display	729	Deutsch-englisches Glossar	745
Protein Interactions: The Yeast Two-Hybrid System	732	Internetlinks für Deutschland, Österreich und die Schweiz	768
Protein Interaction by Co-Immunoprecipitation	737	Index	770
Protein Arrays	741		
Metabolomics	741		