

# Contents



Preface.....	xi
--------------	----

---

## Q U A L I T Y I S S U E S

1. Quality Systems: Theory and Practice.....	1
<i>Tania L. Motschman, MS, MT(ASCP)SBB, CQA(ASQ);</i> <i>Betsy W. Jett, MT(ASCP), CQA, CQM/OE(ASQ); and</i> <i>Susan L. Wilkinson, EdD, MS, MT(ASCP)SBB, CQA(ASQ)</i>	
Quality Concepts .....	2
Practical Application of Quality Principles .....	4
References .....	30
Appendix 1-1. Glossary of Commonly Used Quality Terms .....	32
Appendix 1-2. Code of Federal Regulations Quality-Related References.....	34
Appendix 1-3. Statistical Tables for Binomial Distribution Used to Determine Adequate Sample Size and Level of Confidence for Validation of Pass/Fail Data .....	35
Appendix 1-4. Suggested Quality Control Performance Intervals for Equipment and Reagents .....	37
2. Facilities, Work Environment, and Safety .....	41
<i>Betsy W. Jett, MT(ASCP), CQA, CQM/OE(ASQ); Susan L. Wilkinson, EdD, MS,</i> <i>MT(ASCP)SBB; and Tania Motschman, MS, MT(ASCP)SBB, CQA(ASQ)</i>	
Facilities.....	42
Safety Program .....	44
Fire Prevention.....	49
Electrical Safety.....	50
Biosafety .....	51
Chemical Safety .....	59
Radiation Safety .....	64

Shipping Hazardous Materials . . . . .	67
General Waste Management . . . . .	68
Disaster Planning . . . . .	68
Uniforms and Laboratory Coats . . . . .	75
Gloves . . . . .	75
Face Shields, Masks, and Safety Goggles . . . . .	76
Hand-Washing . . . . .	77
Eyewashes . . . . .	77
References . . . . .	77
Appendix 2-1. Safety Regulations and Recommendations Applicable to Health-Care Settings . . . . .	73
Appendix 2-2. General Guidelines for Safe Work Practices, Personal Protective Equipment, and Engineering Controls . . . . .	75
Appendix 2-3. Biosafety Level 2 Precautions . . . . .	79
Appendix 2-4. Sample Hazardous Chemical Data Sheet . . . . .	81
Appendix 2-5. Sample List of Hazardous Chemicals in the Blood Bank . . . . .	82
Appendix 2-6. Specific Chemical Categories and How to Work Safely with Them . . . . .	84
Appendix 2-7. Incidental Spill Response . . . . .	86
Appendix 2-8. Managing Hazardous Chemical Spills . . . . .	89
3. Regulatory Issues in Blood Banking . . . . .	91
<i>Glenn Ramsey, MD</i>	
Federal Laws and Regulations for Drugs . . . . .	91
Biological Products . . . . .	92
Licensure and Registration . . . . .	93
FDA Inspections . . . . .	94
Blood-Related Devices . . . . .	95
Hematopoietic Progenitor Cells and Other Tissues . . . . .	95
Testing for Infectious Diseases . . . . .	96
Managing Recalls and Withdrawals . . . . .	97
Medical Laboratory Laws and Regulations . . . . .	97
State and Local Regulations . . . . .	99
Conclusion . . . . .	100
References . . . . .	100
4. Disaster Management . . . . .	103
<i>Jamie Blietz, MBA, CAE; William P. FitzGerald, LTC USA (Ret); and Ruth D. Sylvester, Lt Col, USAF (Ret), MS, MT(ASCP)SBB</i>	
Business Operations Planning . . . . .	108
Working with Emergency Management Agencies . . . . .	121
Regulatory Considerations in Emergencies . . . . .	123
Testing the Disaster Plan . . . . .	125



Summary of Lessons Learned from Recent Disasters . . . . .	127
Conclusion . . . . .	127
References . . . . .	132
Appendix 4-1. Internet Resources Related to State and Local Organizations . . .	135
Appendix 4-2. General Internet Resources for Disaster Management . . . . .	135

---

B L O O D   D O N A T I O N   A N D   C O L L E C T I O N

5.	Allogeneic and Autologous Blood Donor Selection . . . . .	137
	<i>Anne F. Eder, MD, PhD</i>	
	Historical Perspective. . . . .	138
	Selection of Allogeneic Donors. . . . .	140
	Possible Measures of the Effectiveness of the Donor Interview. . . . .	147
	Blood Center-Defined Donor Eligibility Criteria . . . . .	148
	Abbreviated Donor History Questionnaire for Frequent Donors. . . . .	153
	Postdonation Instructions. . . . .	153
	Recipient-Specific “Designated” Blood Donation . . . . .	154
	References . . . . .	156
	Appendix 5-1. Requirements for Allogeneic and Autologous Donor Qualification . . . . .	161
	Appendix 5-2. The Donor History Questionnaire and Corresponding Regulations and Standards . . . . .	164
	Appendix 5-3. Full-Length Donor History Questionnaire. . . . .	182
	Appendix 5-4. Medication Deferral List for the Donor History Questionnaire . . . . .	185
	Appendix 5-5. Blood Donor Educational Materials: Making Your Blood Donation Safe . . . . .	186
6.	Whole Blood Collection and Component Processing. . . . .	189
	<i>Ram Kakaiya, MD, MBBS; Colleen A. Aronson, MT(ASCP)SBB; and Jana Julleis, MT(ASCP)SBB</i>	
	Whole Blood Collection . . . . .	189
	Blood Component Preparation and Processing . . . . .	197
	Quality Control of Blood Components . . . . .	220
	References . . . . .	225
7.	Blood Component Collection by Apheresis. . . . .	229
	<i>James W. Smith, MD, PhD, and Edwin A. Burgstaler, MT(ASCP), HP</i>	
	Component Collection . . . . .	229
	Instruments and Systems for Donor Apheresis Collections. . . . .	235
	References . . . . .	238

8.	Infectious Disease Screening . . . . .	241
	<i>Eberhard W. Fiebig, MD, and Michael P. Busch, MD, PhD</i>	
	Transfusion-Transmissible Pathogens . . . . .	241
	Strategies to Prevent Infectious Disease Transmission by Blood Transfusion . . .	260
	References . . . . .	278
9.	Storage, Monitoring, Pretransfusion Processing, and Distribution of Blood Components . . . . .	283
	<i>William B. Lockwood, PhD, MD; Jill Leonard, MT(AMT); and Sandy L. Liles, MT(ASCP)SBB</i>	
	Blood and Blood Component Storage . . . . .	284
	Prestorage Processing. . . . .	291
	Poststorage Processing. . . . .	292
	Inspection, Shipping, Receiving into Inventory, Disposition, and Issue . . . . .	295
	References . . . . .	298

---

I M M U N O L O G I C A N D G E N E T I C P R I N C I P L E S

10.	Molecular Biology and Immunology in Transfusion Medicine . . . . .	301
	<i>James C. Zimring, MD, PhD, and Steven L. Spitalnik, MD</i>	
	Nucleic Acid Analysis. . . . .	301
	Protein Analysis . . . . .	315
	References . . . . .	322
11.	Blood Group Genetics . . . . .	325
	<i>Christine Lomas-Francis, MSc, FIBMS</i>	
	Fundamental Principles of Genetics. . . . .	326
	Inheritance of Genetic Traits. . . . .	334
	Population Genetics. . . . .	347
	Relationship Testing . . . . .	351
	Blood Group Gene Mapping. . . . .	353
	Chimerism . . . . .	353
	Blood Group Terminology . . . . .	356
	References . . . . .	359




---

 B L O O D   G R O U P S

12.	ABO, H, and Lewis Blood Groups and Structurally Related Antigen	361
	<i>Laura Cooling, MD, MS</i>	
	ABO System	361
	The H System	372
	The Lewis System	374
	I and i Antigens	377
	P Blood Group	380
	References	383
13.	The Rh System	387
	<i>Connie M. Westhoff, PhD, MT(ASCP)SBB</i>	
	Terminology	388
	RH Genes and Rh Proteins	391
	Antigens	392
	<i>RH</i> Genotyping	401
	Rh <sub>null</sub> Syndrome and RhAG	402
	Rh Structure and Function	403
	Rh Antibodies	403
	Technical Considerations for Rh Typing	404
	References	406
	Suggested Reading	409
14.	Other Blood Groups	411
	<i>Geoff Daniels, PhD, FRCPath</i>	
	The MNS System	411
	The Lutheran System	417
	The Kell and Kx Systems	418
	The Duffy System	421
	The Kidd System	423
	The Diego System	425
	The Yt System	426
	The Xg System	426
	The Scianna System	427
	The Dombrock System	427
	The Colton System	428
	The Landsteiner-Wiener System	429
	The Chido/Rodgers System	429

The Gerbich System . . . . .	429
The Cromer System . . . . .	430
The Knops System . . . . .	431
The Indian System . . . . .	431
The Ok System . . . . .	432
The Raph System . . . . .	432
The John Milton Hagen System . . . . .	432
The Gill System . . . . .	432
Antigens That Do Not Belong to a Blood Group System . . . . .	432
References . . . . .	434

---

A N T I G E N   A N D   A N T I B O D Y   T E S T I N G

15. Pretransfusion Testing . . . . .	437
<i>Katharine A. Downes, MD, and Ira A. Shulman, MD</i>	
Requests for Transfusion . . . . .	437
Identification of Recipients and Labeling of Blood Specimens . . . . .	438
Specimen Requirements . . . . .	441
Serologic Testing Principles . . . . .	442
Pretransfusion Tests . . . . .	447
Tubeless Methods for Pretransfusion Testing . . . . .	450
Comparison of Current Testing Results with Previous Records . . . . .	451
Donor RBC Unit Testing . . . . .	451
Donor RBC Unit Selection . . . . .	451
Compatibility Testing or Crossmatch (Serologic or Computer/Electronic) . . . . .	452
Interpretation of Antibody Screening and Crossmatch Results . . . . .	454
Pretransfusion Orders . . . . .	456
Availability of Compatible Blood . . . . .	456
Labeling of Blood and Blood Components with the Recipient's Information . . . . .	458
Special Clinical Situations . . . . .	459
References . . . . .	460
16. Identification of Antibodies to Red Cell Antigens . . . . .	465
<i>Phyllis S. Walker, MS, MT(ASCP)SBB</i>	
Significance of Alloantibodies . . . . .	465
Preanalytical Considerations . . . . .	466
Analytical Phase of Antibody Identification . . . . .	468
Postanalytical Interpretation . . . . .	493
References . . . . .	496
Suggested Readings . . . . .	497



17.	The Positive Direct Antiglobulin Test and Immune-Mediated Hemolysis .....	499
	<i>Regina M. Leger, MSQA, MT(ASCP)SBB, CMQ/OE(ASQ)</i>	
	The Direct Antiglobulin Test .....	499
	Autoimmune Hemolytic Anemia .....	504
	Drug-Induced Immune Hemolytic Anemia .....	515
	References .....	519
	Appendix 17-1. Drugs Associated with a Positive DAT and/or Immune Hemolytic Anemia .....	522
18.	Platelet and Granulocyte Antigens and Antibodies .....	525
	<i>Janice G. McFarland, MD</i>	
	Platelet Antigens and Antibodies .....	525
	Granulocyte Antigens and Antibodies .....	540
	References .....	542
19.	The HLA System .....	547
	<i>Howard M. Gebel, PhD; Marilyn S. Pollack, PhD; and Robert A. Bray, PhD</i>	
	Genetics of the Major Histocompatibility Complex .....	548
	Biochemistry, Tissue Distribution, and Structure .....	552
	Detection of HLA Antigens and Alleles .....	556
	The HLA System and Transfusion .....	559
	HLA Testing and Transplantation .....	562
	Other Clinically Significant Aspects of HLA .....	564
	Summary .....	566
	References .....	566
<hr/>		
CLINICAL CONSIDERATIONS IN TRANSFUSION PRACTICE		
20.	Hemotherapy Decisions and Their Outcomes .....	569
	<i>James P. AuBuchon, MD</i>	
	Red Cell Transfusion .....	569
	Platelet Transfusion .....	579
	Plasma Transfusion .....	589
	Cryoprecipitated AHF .....	593
	Granulocyte Transfusion .....	595
	Plasma Derivatives .....	597
	References .....	603

21.	Administration of Blood Components . . . . .	613
	<i>Bonnie L. S. Sink, BSN, RN, HP(ASCP)</i>	
	Predispensing Events and Considerations . . . . .	613
	Dispensing and Transportation . . . . .	617
	Preadministration Events and Considerations . . . . .	618
	Administration . . . . .	620
	Unique Transfusion Settings . . . . .	621
	Conclusion . . . . .	622
	References . . . . .	623
22.	Perinatal Issues in Transfusion Practice . . . . .	625
	<i>Melanie S. Kennedy, MD</i>	
	Hemolytic Disease of the Fetus and Newborn . . . . .	625
	Rh Immune Globulin . . . . .	630
	ABO Hemolytic Disease . . . . .	633
	Immune Thrombocytopenia . . . . .	633
	References . . . . .	636
23.	Neonatal and Pediatric Transfusion Practice . . . . .	639
	<i>Cassandra D. Josephson, MD</i>	
	Transfusion in Infants Less than 4 Months of Age . . . . .	639
	Transfusion of Older Infants (More than 4 Months of Age) and Children . . . . .	654
	Prevention of Adverse Effects of Transfusion in Neonates and Older Children . . . . .	657
	References . . . . .	659
24.	Blood Management . . . . .	665
	<i>Jonathan H. Waters, MD</i>	
	Behavioral Changes . . . . .	665
	Preoperative Anemia Management . . . . .	666
	Perioperative Autotransfusion Program . . . . .	667
	References . . . . .	675
25.	Transfusion Support for Hematopoietic Transplant Recipients . . . . .	679
	<i>Zbigniew M. Szczepiorkowski, MD, PhD, FCAP</i>	
	ABO and Red Cell Antigen Incompatible Transplantation . . . . .	681
	Transfusion Support for ABO-Incompatible Transplant Recipients . . . . .	685
	HSCT Recipients with HLA and/or Platelet Antibodies . . . . .	690



	Neutropenic Patients with Infection Unresponsive to Antimicrobial Therapy . . . . .	691
	Utilization of Blood Components by HSCT Recipients . . . . .	692
	Special Processing of Blood Components for the Recipients of HSCT . . . . .	693
	Other Practical Considerations . . . . .	694
	References . . . . .	694
26.	Therapeutic Apheresis . . . . .	697
	<i>Robertson D. Davenport, MD</i>	
	Modalities . . . . .	698
	Indications . . . . .	699
	Anticoagulation . . . . .	705
	Replacement Fluids . . . . .	705
	Adverse Effects . . . . .	707
	Vascular Access . . . . .	709
	Patient Evaluation . . . . .	711
	References . . . . .	711
27.	Noninfectious Complications of Blood Transfusion . . . . .	715
	<i>Catherine A. Mazzei, MD; Mark A. Popovsky, MD; and Patricia M. Kopko, MD</i>	
	Recognition and Evaluation of a Suspected Transfusion Reaction . . . . .	715
	Acute or Immediate Transfusion Reactions . . . . .	724
	Fatality Reporting Requirements . . . . .	745
	References . . . . .	745
28.	Approaches to Blood Utilization Auditing . . . . .	751
	<i>Alan Tinmouth, MD, FRCPC, MSc</i>	
	Rationale for Monitoring Blood Utilization . . . . .	752
	Types of Transfusion Audits . . . . .	752
	Interventions to Change Transfusion Practice . . . . .	757
	Effectiveness of Monitoring and Interventions to Change Transfusion Practice . . . . .	758
	Selecting an Audit Process to Monitor Transfusions . . . . .	759
	Conclusion . . . . .	760
	References . . . . .	745
	Appendix 28-1. Example of a Transfusion Order Form . . . . .	762

---

 T R A N S P L A N T A T I O N
 

---

29.	Collecting and Processing Marrow Products for Transplantation . . . . .	765
	<i>Janice Davis-Sproul, MAS, MT(ASCP)SBB; N. Rebecca Haley, MD; and John D. McMannis, PhD</i>	
	Diseases Treated with Hematopoietic Transplantation . . . . .	766
	Autologous Hematopoietic Cell Transplantation . . . . .	768
	Allogeneic Hematopoietic Cell Transplantation . . . . .	768
	Unrelated Donor Transplantation . . . . .	768
	Histocompatibility . . . . .	769
	Graft-vs-Host Disease . . . . .	769
	Autologous Donors . . . . .	769
	Allogeneic Donors . . . . .	770
	Marrow Harvest . . . . .	771
	Collection Targets . . . . .	771
	Clinical Considerations . . . . .	771
	CD34 Antigen . . . . .	771
	Processing of HPC-M Products . . . . .	772
	ABO Incompatibilities . . . . .	774
	Short- and Long-Term Storage . . . . .	776
	Transportation and Shipping . . . . .	778
	Thawing and Infusion . . . . .	778
	Evaluation and Quality Control of Hematopoietic Products . . . . .	779
	Regulations . . . . .	780
	Standards . . . . .	780
	References . . . . .	781
30.	Hematopoietic Progenitor Cells Collected by Apheresis . . . . .	787
	<i>Thomas Lane, MD, and John D. McMannis, PhD</i>	
	Biology of HPC Mobilization . . . . .	788
	Clinical Mobilization Regimens . . . . .	789
	Clinical Use of HPC-A . . . . .	795
	Selection of an HPC-A Graft vs an HPC-M Graft . . . . .	798
	Clinical Transplantation Outcomes of HPC-A vs HPC-M Grafts . . . . .	799
	Selection of an HPC-A or HPC-M Graft vs an HPC-C Graft . . . . .	800
	References . . . . .	801
31.	Umbilical Cord Blood . . . . .	809
	<i>David H. McKenna, MD; Diane M. Kadidlo, MT(ASCP)SBB; and Jeffrey McCullough, MD</i>	
	Donor-Related Issues . . . . .	810



Collection . . . . .	814
Processing . . . . .	816
Tests after Thawing and Stability Testing . . . . .	818
Shipment and Storage . . . . .	818
Receipt of UCB for Transplantation. . . . .	819
Thawing and Washing of UCB . . . . .	821
Infusion of UCB . . . . .	822
Regulations and Standards . . . . .	823
Novel UCB-Derived Cellular Therapies. . . . .	825
References . . . . .	827
32. Tissue and Organ Transplantation and the Hospital Tissue Transplantation Service . . . . .	833
<i>Ted Eastlund, MD</i>	
Tissue Transplantation . . . . .	833
Hospital Tissue Transplantation Services . . . . .	838
Organ Transplantation and the Hospital Blood Transfusion Service . . . . .	850
Diagnosis of Complications . . . . .	862
Bacterial Infections. . . . .	862
Viral, Prion, and Fungal Infections . . . . .	862
Reporting of Adverse Clinical Outcomes to Physician Peers. . . . .	863
Reporting of Suspected Adverse Outcomes to the Hospital Tissue Transplantation Service by the Physician . . . . .	863
Reporting of Adverse Outcomes to the FDA by the Physician . . . . .	863
Disclosure of Adverse Outcomes to Patients. . . . .	863
References . . . . .	856
Appendix 32-1. Special Expertise of a Hospital Blood Transfusion Service to Serve as a Hospital Tissue Service. . . . .	860
Appendix 32-2. One Example of Responsibilities of a Hospital Tissue Services Committee for Medical Staff Oversight . . . . .	861
Appendix 32-3. Roles of the Recipient's Physician in the Recognition and Reporting of Suspected Adverse Events Related to Tissue Allografts . . . .	862

---

M E T H O D S

Methods Introduction. . . . .	865
1. General Laboratory Methods. . . . .	867
Introduction . . . . .	867
Method 1-1. Shipping Hazardous Materials . . . . .	867
Method 1-2. Treating Incompletely Clotted Specimens. . . . .	870
Method 1-3. Solution Preparation Procedure. . . . .	871
Method 1-4. Serum Dilution Procedure . . . . .	873

Method 1-5. Dilution of % Solutions Procedure . . . . .	874
Method 1-6. Preparing a 3% Red Cell Suspension . . . . .	874
Method 1-7. Preparing and Using Phosphate Buffer . . . . .	875
Method 1-8. Reading and Grading Tube Agglutination. . . . .	876
<b>2. Red Cell Typing. . . . .</b>	<b>877</b>
Method 2-1. Determining ABO Type of Red Cells—Slide test . . . . .	877
Method 2-2. Determining ABO Group of Red Cells and Serum— Tube Test . . . . .	878
Method 2-3. Determining ABO Group of Red Cells and Serum— Microplate Test . . . . .	879
Method 2-4. Initial Investigation of ABO Grouping Discrepancies Procedure . . . . .	880
Method 2-5. Detecting Weak A and B Antigens and Antibodies by Cold Temperature Enhancement . . . . .	881
Method 2-6. Confirming Weak A and B Antigens Using Enzyme- Treated Red Cells. . . . .	882
Method 2-7. Confirming Weak A or B Subgroup by Adsorption and Elution . .	882
Method 2-8. Testing Saliva for A, B, H, Le <sup>a</sup> , and Le <sup>b</sup> Antigens . . . . .	883
Method 2-9. Confirming anti-A1 in an A2 or Weak A Subgroup. . . . .	886
Method 2-10. Resolving ABO Discrepancies Caused by Unexpected Alloantibodies . . . . .	886
Method 2-11. Determining Serum Group Without Centrifugation . . . . .	887
Method 2-12. Determining Rh (D) Type—Slide Test . . . . .	887
Method 2-13. Determining Rh (D) Type—Tube Test . . . . .	888
Method 2-14. Determining Rh (D) Type—Microplate Test . . . . .	889
Method 2-15. Testing for Weak D . . . . .	889
Method 2-16. Preparing and Using Lectins. . . . .	890
Method 2-17. Removing Autoantibody by Warm Saline Washes. . . . .	892
Method 2-18. Using Sulphydryl Reagents to Disperse Autoagglutination . . . .	892
Method 2-19. Using Gentle Heat Elution to Test Red Cells with a Positive DAT . . . . .	893
Method 2-20. Dissociating IgG by Chloroquine for Antigen Testing of Red Cells with a Positive DAT . . . . .	894
Method 2-21. Using Acid Glycine/EDTA to Remove Antibodies from Red Cells. . . . .	895
Method 2-22. Separating Transfused from Autologous Red Cells by Simple Centrifugation. . . . .	896
Method 2-23. Separating Transfused Red Cells from Autologous Red Cells in Patients with Hemoglobin S Disease. . . . .	897
<b>3. Antibody Detection, Identification, and Compatibility Testing . . . . .</b>	<b>899</b>
Method 3-1. Using Immediate-Spin Compatibility Testing to Demonstrate ABO Incompatibility . . . . .	899



Method 3-2. Detecting Antibodies to Red Cell Antigens—Indirect Antiglobulin Tests . . . . .	900
Method 3-3. Prewarming Procedure . . . . .	902
Method 3-4. Detecting Antibodies in the Presence of Rouleaux—Saline Replacement. . . . .	903
Method 3-5. Enzyme Procedures . . . . .	904
Method 3-6. Performing a Direct Antiglobulin Test . . . . .	908
Method 3-8. Using Sulfhydryl Reagents to Distinguish IgM from IgG Antibodies. . . . .	911
Method 3-9. Using Plasma Inhibition to Distinguish Anti-Ch and -Rg from Other Antibodies with Similar Characteristics. . . . .	913
Method 3-10. Treating Red Cells Using DTT Or AET . . . . .	914
Method 3-11. Neutralizing Anti-Sd <sup>a</sup> with Urine. . . . .	915
Method 3-12. Adsorption Procedure . . . . .	916
Method 3-13. Using the American Rare Donor Program . . . . .	917
 4. Investigation of a Positive DAT . . . . .	 919
Eluates . . . . .	919
Method 4-1. Cold-Acid Elution Procedure . . . . .	919
Method 4-2. Glycine-HCl/EDTA Elution Procedure . . . . .	920
Method 4-3. Heat Elution Procedure. . . . .	921
Method 4-4. Lui Freeze-Thaw Elution Procedure . . . . .	921
Immune Hemolytic Anemia Serum/Plasma Methods . . . . .	922
Method 4-5. Cold Autoadsorption Procedure . . . . .	922
Method 4-6. Determining the Specificity of Cold-Reactive Autoagglutinins. . . . .	923
Method 4-7. Cold Agglutinin Titer Procedure . . . . .	925
Method 4-8. Adsorbing Warm-Reactive Autoantibodies Using Autologous Red Cells . . . . .	926
Method 4-9. Adsorbing Warm-Reactive Autoantibodies Using Allogeneic Red Cells . . . . .	927
Method 4-10. Polyethylene Glycol Adsorption Procedure . . . . .	929
Method 4-11. Performing The Donath-Landsteiner Test . . . . .	930
Method 4-12. Detecting Drug Antibodies by Testing Drug-Treated Red Cells. . . . .	931
Method 4-13. Detecting Drug Antibodies by Testing in the Presence of Drug . . . . .	933
 5. Hemolytic Disease of the Fetus and Newborn . . . . .	 935
Method 5-1. Testing for Fetomaternal Hemorrhage—The Rosette Test . . . . .	935
Method 5-2. Testing for Fetomaternal Hemorrhage—Modified Kleihauer-Betke Test. . . . .	936
Method 5-3. Using Antibody Titration Studies to Assist in Early Detection of Hemolytic Disease of the Fetus and Newborn . . . . .	937

6.	Blood Collection, Component Preparation, and Storage . . . . .	941
	Method 6-1. Screening Donors for Anemia—Copper Sulfate Method . . . . .	941
	Method 6-2. Preparing the Donor’s Arm for Blood Collection. . . . .	942
	Method 6-3. Collecting Blood and Samples for Processing and Compatibility Tests . . . . .	943
	Method 6-4. Preparing Red Blood Cells from Whole Blood . . . . .	946
	Method 6-5. Preparing Prestorage Red Blood Cells Leukocytes Reduced from Whole Blood. . . . .	947
	Method 6-6. Rejuvenating Red Blood Cells. . . . .	948
	Method 6-7. Using High-Concentration Glycerol to Cryopreserve Red Cells—Meryman Method . . . . .	949
	Method 6-8. Using High-Concentration Glycerol to Cryopreserve Red Cells—Valeri Method . . . . .	952
	Method 6-9. Checking the Adequacy of Deglycerolization of Red Blood Cells . . . . .	954
	Method 6-10. Preparing Fresh Frozen Plasma from Whole Blood . . . . .	955
	Method 6-11. Preparing Cryoprecipitated AHF from Whole Blood . . . . .	956
	Method 6-12. Thawing and Pooling Cryoprecipitated AHF . . . . .	957
	Method 6-13. Preparing Platelets from Whole Blood . . . . .	958
	Method 6-14. Removing Plasma from Platelets (Volume Reduction) . . . . .	960
7.	Transplantation of Cells and Tissue . . . . .	963
	Method 7-1. Infusing Cryopreserved Hematopoietic Cells . . . . .	963
	Method 7-2. Processing Umbilical Cord Blood . . . . .	964
	Method 7-3. Qualifying Tissue Suppliers. . . . .	965
	Method 7-4. Autologous Tissue Collection, Packaging, Testing, Storage, and Release Procedures. . . . .	966
	Method 7-5. Investigating Adverse Events and Infections Following Tissue Allograft Use . . . . .	968
8.	Quality Control. . . . .	973
	Method 8-1. Validating Copper Sulfate Solution . . . . .	973
	Method 8-2. Standardizing and Calibrating Thermometers . . . . .	973
	Method 8-3. Testing Blood Storage Equipment Alarms. . . . .	975
	Method 8-4. Calibrating Centrifuges for Platelet Separation. . . . .	978
	Method 8-5. Calibrating a Serologic Centrifuge . . . . .	980
	Method 8-6. Testing Automatic Cell Washers . . . . .	982
	Method 8-7. Monitoring Cell Counts of Apheresis Components. . . . .	983
	Method 8-8. Counting Residual White Cells in Leukocyte-Reduced Blood and Components—Manual Method . . . . .	984



---

A P P E N D I C E S

Appendix 1. Normal Values in Adults . . . . .	987
Appendix 2. Selected Normal Values in Children. . . . .	988
Appendix 3. Typical Normal Values in Tests of Hemostasis and Coagulation (Adults) . . . . .	990
Appendix 4. Coagulation Factor Values in Platelet Concentrates. . . . .	990
Appendix 5. Approximate Normal Values for Red Cell, Plasma, and Blood Volumes . . . . .	991
Appendix 6. Blood Group Antigens Assigned to Systems . . . . .	992
Appendix 7. Examples of Gene, Antigen, and Phenotype Symbols in Conventional and International Society of Blood Transfusion Terminology . . . . .	997
Appendix 8. Examples of Correct and Incorrect Terminology . . . . .	997
Appendix 9. Distribution of ABO/Rh Phenotypes by Race or Ethnicity . . . . .	998
Appendix 10. Directory of Organizations . . . . .	999
Appendix 11. Resources for Safety Information . . . . .	1001
Index. . . . .	1003