WILLIAMS **M M Y**

Williams Hematology 9E

第9版・英文版

Kenneth Kaushansky Marshall A. Lichtman Josef T. Prchal Marcel M. Levi Oliver W. Press Linda J. Burns Michael A. Caligiuri







第9版・英文版

Williams Hematology 9E

Kenneth Kaushansky, MD, MACP

Senior Vice President for Health Sciences Dean, School of Medicine SUNY Distinguished Professor Stony Brook University Stony Brook, New York

Josef T. Prchal, MD

Professor of Medicine, Pathology, and Genetics Hematology Division University of Utah Salt Lake City, Utah Department of Pathophysiology First Faculty of Medicine Charles University in Prague Prague, Czech Republic

Oliver W. Press, MD, PhD

Acting Director, Clinical Research Division
Dr. Penny E. Peterson Memorial Chair for Lymphoma
Research
Fred Hutchinson Cancer Research Center
Professor of Medicine and Bioengineering
University of Washington
Seattle, Washington

Marshall A. Lichtman, MD

Professor of Medicine and of Biochemistry and Biophysics University of Rochester Medical Center Rochester, New York

Marcel Levi, MD, PhD

Professor of Medicine Dean, Faculty of Medicine Academic Medical Center University of Amsterdam Amsterdam, The Netherlands

Linda J. Burns, MD

Professor of Medicine Division of Hematology, Oncology and Transplantation University of Minnesota Minneapolis, Minnesota

Michael A. Caligiuri, MD

Director, Comprehensive Cancer Center CEO, James Cancer Hospital and Solove Research Institute Professor of Medicine The Ohio State University Columbus, Ohio



图书在版编目(CIP)数据

Williams血液学: 第9版: 英文/(美) 考杉斯基,(美) 里奇曼, (美) 佩查著. — 北京: 北京联合出版公司, 2017.1 ISBN 978-7-5502-9362-5

I. ①W… II. ①考… ②里… ③佩… III. ①血液学—英文 IV. ①R331.1 中国版本图书馆CIP数据核字(2016)第287731号

 $Kenneth\,Kaushansky, Marshall\,A.\,Lichtman, Josef\,T.\,Prchal, Marcel\,M.\,Levi, Oliver\,W.\,Press, Linda\,J.\,Burns, Michael\,A.\,Caligiuri\,Williams\,Hematology, Ninth\,Edition$

ISBN 978-0-07-183300-4

Copyright © 2016 by McGraw-Hill Education.

All Rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including without limitation photocopying, recording, taping, or any database, information or retrieval system, without the prior written permission of the publisher.

This authorized English reprint edition is jointly published by McGraw-Hill Education and Beijing United Publishing Co.,Ltd. This edition is authorized for sale in the People's Republic of China only, excluding Hong Kong, Macao SAR and Taiwan.

Copyright © 2017 by McGraw-Hill Education.

版权所有。未经出版人事先书面许可,对本出版物的任何部分不得以任何方式或途径复制或传播,包括但不限于复印、录制、录音,或通过任何数据库、信息或可检索的系统。

本授权英文影印版由麦格劳-希尔(亚洲)教育出版公司和北京联合出版公司合作出版。此版本经授权仅限在中华人民共和国境内(不包括香港特别行政区、澳门特别行政区和台湾)销售。

版权©2017由麦格劳-希尔(亚洲)教育出版公司所有。

本书封面贴有McGraw-Hill Education公司防伪标签,无标签者不得销售。

北京市版权局著作权合同登记号: 01-2016-8865

Williams 血液学(第9版)

著 者: Kenneth Kaushansky 等

选题策划:后浪出版公司

出版统筹: 吴兴元

特约编辑:张忠丽

责任编辑:李 征

营销推广: ONEBOOK

装帧制造:墨白空间·张 莹

北京联合出版公司出版

(北京市西城区德外大街83号楼9层 100088)

北京盛通印刷股份有限公司印刷 新华书店经销

字数4500千字 889毫米×1194毫米 1/16 158印张

2017年3月第1版 2017年3月第1次印刷

ISBN 978-7-5502-9362-5

定价: 1198.00元

后浪出版吉询(北京)有限责任公司常年法律顾问:北京大成律师事务所 周天晖 copyright@hinabook.com

未经许可,不得以任何方式复制或抄袭本书部分或全部内容

版权所有,侵权必究

本书若有质量问题,请与本公司图书销售中心联系调换。电话: 010-64010019

Williams Hematology

Notice

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required. The authors and the publisher of this work have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication. However, in view of the possibility of human error or changes in medical sciences, neither the authors nor the publisher nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions or for the results obtained from use of the information contained in this work. Readers are encouraged to confirm the information contained herein with other sources. For example and in particular, readers are advised to check the product information sheet included in the package of each drug they plan to administer to be certain that the information contained in this work is accurate and that changes have not been made in the recommended dose or in the contraindications for administration. This recommendation is of particular importance in connection with new or infrequently used drugs.

PREFACE

The first edition of *Williams Hematology* (né *Hematology*) was published in 1972. This, our 9th edition, will represent our continued efforts over nearly one-half century to provide the most current concepts of the pathophysiology and treatment of hematologic diseases.

The rate of growth in our understanding of diseases of blood cells and coagulation pathways provides a challenge for editors of a comprehensive textbook of hematology. The sequencing of individual genomes, analysis of the "dark DNA" and noncoding RNAs, advances in knowledge in proteomics, metabolomics, and other "-omics" fields, as applied to hematologic disorders, have accelerated the understanding of the pathogenesis of the diseases of our interest. The rate at which basic knowledge in molecular and cellular biology and immunology has been translated into improved diagnostic and therapeutic methods is equally impressive. Specific molecular targets for therapy in several hematologic disorders have become reality, and it is not hyperbole to state that hematology is the poster child for the rational design of therapeutics applicable to other fields of medicine.

This edition of Williams Hematology includes changes designed to facilitate ease of access to information, both within the book and its associated links, and has been modestly reorganized to reflect our greater understanding of the origins of hematologic disorders. Each chapter has been revised or rewritten to provide current information. Four new chapters have been added and other notable changes have been made. Chapter 4 "Consultative Hematology" is new to this edition. The chapter "Epigenetics and Genomics" has been divided into separate chapters to reflect the growth of knowledge in those disciplines. Chapter 14, "Metabolism of Hematologic Neoplastic Cells" is new, as this topic has become the basis of multiple potential drug targets for hematologic disease. A section on "Autophagy" has been added to Chap 15 "Apoptosis Mechanisms: Relevance to the Hematopoietic System," as the topic is becoming increasingly important for understanding of the physiology of blood cell development; and an independent chapter "Heparin-Induced Thrombocytopenia" (Chap 118) has been created to reflect both its pathophysiologic and clinical importance. Recognizing that at the heart of diagnostic hematology is blood and marrow cell morphology, we have continued our incorporation of informative color images of the relevant disease topics in each chapter, allowing easy access to illustrations of cell morphology important to diagnosis.

The 9th edition of Williams Hematology is also available online, as part of the excellent www.accessmedicine.com website. With direct links to a comprehensive drug therapy database and to other important medical texts, including Harrison's Principles of Internal Medicine and Goodman and Gilman's The Pharmacological Basis of Therapeutics, Williams Hematology Online is part of a powerful resource covering all disciplines within medical education and practice. The online edition

of Williams Hematology also includes PubMed links to journal articles cited in the references.

In addition, *Williams Manual of Hematology* will be revised to reflect the diagnostic and therapeutic advances incorporated in the 9th edition of *Williams Hematology*. The convenient *Manual* features the most clinically salient content from the parent text, and is useful in time-restricted clinical situations. The *Manual* will be available for iPhone™ and other mobile formats.

The readers of the 9th edition of *Williams Hematology* will note a "changing of (some of) the guard" of our editorial group; Drs. Marcel Levi (a member of the 8th edition of *Williams Manual of Hematology* editorial group), Oliver Press, Linda Burns, and Michael Caligiuri have joined continuing editors Drs. Kenneth Kaushansky, Marshall Lichtman, and Josef Prchal in the 9th edition.

The production of this book required the timely cooperation of 101 contributors for the production of 139 chapters. We are grateful for their work in providing this comprehensive and up-to-date text. Despite the growth of both basic and clinical knowledge and the passion that each of our contributors brings to the topic of their chapter, we have been able to maintain the text in a single volume through scrupulous attention to chapter length.

Each editor has had expert administrative assistance in the management of the manuscripts for which they were primarily responsible. We thank Susan Madden in Salt Lake City, Utah; Nancy Press and Deborah Lemon in Seattle, Washington; and Annie Thompson, Rebecca Posey, and Kimberly Morley in Columbus, Ohio for their very helpful participation in the production of the book. Special thanks go to Susan Daley in Rochester, New York, and Marie Brito in Stony Brook, New York, who were responsible for coordinating the management of 139 chapters, including many new figures and tables, and managing other administrative matters, a challenging task that Ms. Daley and Ms. Brito performed with skill and good humor. The editors also acknowledge the interest and support of our colleagues at McGraw-Hill, including James F. Shanahan, Publisher, Medical Publishing; Karen Edmonson, Senior Editor for Williams Hematology; and Harriet Lebowitz, Senior Project Development Editor for Williams Hematology.

Kenneth Kaushansky Marshall A. Lichtman Joseph T. Prchal Marcel Levi Oliver W. Press Linda J. Burns Michael A. Caligiuri

CONTENTS

Contributors ix	16. Cell-Cycle Regulation and Hematologic Disorders
Preface	17. Signal Transduction Pathways
PARTI	Kenneth Kaushansky
Clinical Evaluation of the Patient	18. Hematopoietic Stem Cells, Progenitors, and Cytokines 257 <i>Kenneth Kaushansky</i>
1. Initial Approach to the Patient: History and Physical Examination	19. The Inflammatory Response
Marshall A. Lichtman and Linda J. Burns 2. Examination of Blood Cells	20. Innate Immunity
3. Examination of The Marrow	21. Dendritic Cells and Adaptive Immunity
4. Consultative Hematology	PARTV
Rondeep S. Brar and Stanley L. Schrier	Therapeutic Principles
PART II The Organization of the Lymphohematopoietic Tissues	22. Pharmacology and Toxicity of Antineoplastic Drugs 315 Benjamin Izar, Dustin Dzube, James M. Cleary, Constantine S. Mitsiades, Paul G. Richardson, Jeffrey A. Barnes, and
5. Structure of the Marrow and the Hematopoietic Microenvironment	Bruce A. Chabner 23. Hematopoietic Cell Transplantation
6. The Organization and Structure of Lymphoid Tissues 85 Aharon G. Freud and Michael A. Caligiuri	24. Treatment of Infections in The Immunocompromised Host
PART III Epochal Hematology	25. Antithrombotic Therapy
7. Hematology of the Fetus and Newborn	26. Immune Cell Therapy
8. Hematology during Pregnancy	27. Vaccine Therapy
9. Hematology in Older Persons	28. Therapeutic Apheresis: Indications, Efficacy, and Complications
PARTIV	29. Gene Therapy for Hematologic Diseases
Molecular and Cellular Hematology	30. Regenerative Medicine: Multipotential Cell Therapy for
10. Genetic Principles and Molecular Biology	Tissue Repair
11. Genomics	John Wagner
12. Epigenetics	PART VI The Erythrocyte
13. Cytogenetics and Genetic Abnormalities	31. Structure and Composition of the Erythrocyte
14. Metabolism of Hematologic Neoplastic Cells	32. Erythropoiesis
15. Apoptosis Mechanisms: Relevance to the Hematopoietic	33. Erythrocyte Turnover
System	34. Clinical Manifestations and Classification of Erythrocyte Disorders

35.	Aplastic Anemia: Acquired and Inherited	PARTVII
	George B. Segel and Marshall A. Lichtman	
36.	Pure Red Cell Aplasia	Neutrophils, Eosinophils, Basophils, and Mast Cells 60. Structure and Composition of Neutrophils, Description of Neutrophils,
37.	Anemia of Chronic Disease	Eosinophils, and Basophils
38.	Erythropoietic Effects of Endocrine Disorders 559 <i>Xylina T. Gregg</i>	61. Production, Distribution, and Fate of Neutrophils
39.	The Congenital Dyserythropoietic Anemias	62. Eosinophils and Related Disorders
40.	Paroxysmal Nocturnal Hemoglobinuria	63. Basophils, Mast Cells, and Related Disorders
41.	Folate, Cobalamin, and Megaloblastic Anemias	64. Classification and Clinical Manifestations of Neutrophil Disorders
42.	Iron Metabolism	65. Neutropenia and Neutrophilia
43.	Iron Deficiency and Overload	66. Disorders of Neutrophil Function
44.	Anemia Resulting from Other Nutritional Deficiencies 651 Ralph Green	PART VIII
45.	Anemia Associated with Marrow Infiltration	Monocytes and Macrophages
16	Vishnu VB Reddy and Josef T. Prchal Erythrocyte Membrane Disorders	67. Structure, Receptors, and Functions of Monocytes and
	Theresa L Coetzer	Macrophages
47.	Erythrocyte Enzyme Disorders	68. Production, Distribution, and Activation of Monocytes and
48.	The Thalassemias: Disorders of Globin Synthesis	Macrophages
49.	Disorders of Hemoglobin Structure: Sickle Cell Anemia and Related Abnormalities	69. Classification and Clinical Manifestations of Disorders of Monocytes and Macrophages
50.	Methemoglobinemia and Other Dyshemoglobinemias 789 Archana M. Agarwal and Josef T. Prchal	70. Monocytosis and Monocytopenia
51.	Fragmentation Hemolytic Anemia	71. Inflammatory and Malignant Histiocytosis
52.	Erythrocyte Disorders as a Result of Chemical and Physical Agents	72. Gaucher Disease and Related Lysosomal Storage Diseases 1121 Ari Zimran and Deborah Elstein
	Paul C. Herrmann	PART IX
53.	Hemolytic Anemia Resulting from Infections with Microorganisms	Lymphocytes and Plasma Cells
	Marshall A. Lichtman	73. The Structure of Lymphocytes and Plasma Cells
54.	Hemolytic Anemia Resulting from Immune Injury 823 Charles H. Packman	Natarajan Muthusamy and Michael A. Caligiuri 74. Lymphopoiesis
55.	Alloimmune Hemolytic Disease of the Fetus	Christopher S. Seet and Gay M. Crooks 75. Functions of B Lymphocytes and Plasma Cells in
	and Newborn	Immunoglobulin Production
56.	Hypersplenism and Hyposplenism	76. Functions of T Lymphocytes: T-Cell Receptors
57.	Primary and Secondary Erythrocytoses	for Antigen
58.	The Porphyrias	77. Functions of Natural Killer Cells
59.	Polyclonal and Hereditary Sideroblastic Anemias	78. Classification and Clinical Manifestations of Lymphocyte and Plasma Cell Disorders

vii

79	Lymphocytosis and Lymphocytopenia	101.	Marginal Zone B-Cell Lymphomas
80	Immunodeficiency Diseases	102.	Burkitt Lymphoma
81.	Hematologic Manifestations of Acquired Immunodeficiency Syndrome		Cutaneous T-Cell Lymphoma (Mycosis Fungoides and Sézary Syndrome)
82.	Mononucleosis Syndromes	104.	Mature T-Cell and Natural Killer Cell Lymphomas 1693 Neha Mehta, Alison Moskowitz, and Steven Horwitz
_	RT X		Plasma Cell Neoplasms: General Considerations
	lignant Myeloid Diseases Classification and Clinical Manifestations of the		Essential Monoclonal Gammopathy
65.	Clonal Myeloid Disorders	107.	Marshall A. Lichtman Myeloma
84.	Polycythemia Vera		Elizabeth O'Donnell, Francesca Cottini, Noopur Raje, and Kenneth Anderson
85.	Essential Thrombocythemia		Immunoglobulin Light-Chain Amyloidosis
86.	Primary Myelofibrosis		Macroglobulinemia
87.	Myelodysplastic Syndromes	110.	Giampaolo Merlini Heavy-Chain Disease
88.	Acute Myelogenous Leukemia		Dietlind L. Wahner-Roedler and Robert A. Kyle
89.	Chronic Myelogenous Leukemia and Related Disorders 1437 Jane L. Liesveld and Marshall A. Lichtman	Hem	T XII postasis and Thrombosis
PAR	TXI		Megakaryopoiesis and Thrombopoiesis
	ignant Lymphoid Diseases		Platelet Morphology, Biochemistry, and Function 1829
90.	Classification of Malignant Lymphoid Disorders1493 Robert A. Baiocchi		Susan S. Smyth, Sidney Whiteheart, Joseph E. Italiano Jr., Paul Bray, and Barry S. Coller
	Acute Lymphoblastic Leukemia		Molecular Biology and Biochemistry of the Coagulation Factors and Pathways of Hemostasis
92.	Chronic Lymphocytic Leukemia		Control of Coagulation Reactions
93.	Hairy Cell Leukemia		Vascular Function in Hemostasis
94.	Large Granular Lymphocytic Leukemia		William Muller Classification, Clinical Manifestations, and
95.	General Considerations for Lymphomas: Epidemiology, Etiology, Heterogeneity, and Primary Extranodal Disease 1569 Oliver W. Press and Marshall A. Lichtman		Evaluation of Disorders of Hemostasis
96.	Pathology of Lymphomas		Thrombocytopenia
97.	Hodgkin Lymphoma		Heparin-Induced Thrombocytopenia
	Diffuse Large B-Cell Lymphoma and Related Diseases 1625	(4	Reactive Thrombocytosis
	Stephen D. Smith and Oliver W. Press Follicular Lymphoma		Hereditary Qualitative Platelet Disorders
	Oliver W. Press Mantle Cell Lymphoma		Acquired Qualitative Platelet Disorders
	Martin Dreyling		The Vascular Purpuras

123. Hemophilia A and Hemophilia B	133. Venous Thrombosis
124. Inherited Deficiencies of Coagulation Factors II, V, V+VIII, VII, X, XI, and XIII	134. Atherothrombosis: Disease Initiation, Progression, and Treatment
125. Hereditary Fibrinogen Abnormalities	135. Fibrinolysis and Thrombolysis
126. von Willebrand Disease	PART XIII
127. Antibody-Mediated Coagulation Factor Deficiencies 2183 Sean R. Stowell, John S. (Pete) Lollar, and Shannon L. Meeks	Transfusion Medicine
128. Hemostatic Alterations in Liver Disease and Liver	136. Erythrocyte Antigens and Antibodies
Transplantation	137. Human Leukocyte and Platelet Antigens
129. Disseminated Intravascular Coagulation	138. Blood Procurement and Red Cell Transfusion 2365 Jeffrey McCullough, Majed A. Refaai, and Claudia S. Cohn 139. Preservation and Clinical Use of Platelets 2381 Terry Gernsheimer and Sherrill Slichter Index 2393
130. Hereditary Thrombophilia	
131. The Antiphospholipid Syndrome	
132. Thrombotic Microangiopathies	

CONTRIBUTORS

Charles S. Abrams, MD [121]

Professor of Medicine, Pathology and Laboratory Medicine Vice Chair for Research & Chief Scientific Officer Department of Medicine University of Pennsylvania School of Medicine Philadelphia, Pennsylvania

Archana M. Agarwal, MD [50]

Department of Pathology University of Utah/ARUP Laboratories Salt Lake City, Utah

Doru T. Alexandrescu, MD [122]

Department of Medicine Division of Dermatology University of California, San Diego VA San Diego Health Care System San Diego, California

Carl E. Allen, MD, PhD [71]

Associate Professor of Pediatrics Texas Children's Cancer Center/Hematology Baylor College of Medicine Houston, Texas

Karl E. Anderson, MD, FACP [58]

Professor, Departments of Preventative Medicine and Community Health, Internal Medicine, and Pharmacology and Toxicology University of Texas Medical Branch Galveston, Texas

Kenneth Anderson, MD [107]

Dana-Farber Cancer Institute Boston, Massachusetts

Daniel A. Arber, MD [63]

Ronald F. Dorfman, MBBch, FRCPath Professor in Hematopathology Professor of Pathology Stanford University School of Medicine Stanford University Medical Center Stanford, California

Andrew S. Artz, MD, MS [9]

Associate Professor of Medicine University of Chicago Chicago, Illinois

Farrukh T. Awan, MD [92]

Associate Professor of Internal Medicine Division of Hematology Department of internal Medicine The Ohio State University Comprehensive Cancer Center Columbus, Ohio

Jennifer Babik, MD, PhD [24]

Division of Infectious Diseases Department of Medicine University of California San Francisco, California

Robert A. Baiocchi, MD, PhD [90]

Associate Professor of Medicine Division of Hematology Department of Internal Medicine The Ohio State University Columbus, Ohio

Kelty R. Baker, MD [51]

Clinical Assistant Professor Baylor College of Medicine Houston, Texas

Anannya Banga, PhD, [30]

Assistant Professor Department of Genetics Cell Biology, and Development, Stem Cell Institute University of Minnesota Minneapolis, Minnesota

Jeffrey A. Barnes [22]

Instructor in Medicine Dana-Farber Cancer Institute Harvard Medical School Boston, Massachusetts

Philip A. Beer, MRCP, FRCPath, PhD [85]

Wellcome Trust Sanger Institute Wellcome Trust Genome Campus, Hinxton Cambridge, United Kingdom

Rafael Bejar, MD, PhD [87]

Division of Hematology and Oncology Moores Cancer Center University of California San Diego La Jolla, California

Joel S. Bennett, MD [121]

Professor of Medicine Division of Hematology-Oncology University of Pennsylvania School of Medicine Philadelphia, Pennsylvania

Carolina Berger, MD [26]

Fred Hutchinson Cancer Research Center Seattle, Washington

Robert F. Betts, MD [82]

Professor of Medicine, Emeritus Division of Infectious Diseases University of Rochester Medical Center Rochester, New York

Bruce Beutler, MD [20]

Regental Professor and Director
Center for the Genetics of Host Defense
Raymond and Ellen Willie Distinguished Chair in Cancer Research in
Honor of Laverne and Raymond Willie Sr.
University of Texas Southwestern Medical Center
Dallas, Texas

Lisa Beutler, MD, PhD [24]

Department of Medicine UCSF School of Medicine San Francisco, California

Neil Blumberg, MD [137]

Professor and Director, Clinical Laboratories and Transfusion Medicine Department of Pathology and Laboratory Medicine University of Rochester Rochester, New York

Niels Borregaard, MD, PhD [66]

Professor of Hematology Department of Hematology University of Copenhagen Copenhagen, Denmark

Prithviraj Bose, MD [16]

Assistant Professor Department of Leukemia University of Texas MD Anderson Cancer Center Houston, Texas

Rondeep S. Brar, MD [4]

Clinical Assistant Professor of Medicine (Hematology and Oncology) Stanford University School of Medicine Stanford, California

Paul Bray, MD [112]

Professor Director, Division of Hematology Jefferson University Philadelphia, Pennsylvania

Alessandro Broccoli, MD [101]

Institute of Hematology "L. e A. Seràgnoli" University of Bologna Bologna, Italy

Virginia C. Broudy, MD [81]

Professor of Medicine Scripps Professor of Hematology University of Washington Seattle, Washington

Francis K. Buadi, MD [108]

Division of Hematology Mayo Clinic Rochester, Minnesota

Harry R. Buller, MD [133]

Professor of Medicine, Department of Vascular Medicine Academic Medical Center Amsterdam, The Netherlands

Linda J. Burns, MD [1]

National Marrow Donor Program/Be The Match Vice President and Medical Director Health Services Research Minneapolis, Minnosata

John C. Byrd, MD [92]

 D. Warren Brown Chair of Leukemia Research
 Professor of Medicine, Medicinal Chemistry, and Veterinary Biosciences
 Director, Division of Hematology
 Department of Medicine
 The Ohio State University
 Columbus, Ohio

Bradley R. Cairns, PhD [12]

Howard Hughes Medical Institute Professor and Chair Department of Oncological Sciences Huntsman Cancer Institute University of Utah School of Medicine Salt Lake City, Utah

Michael A. Caligiuri, MD [6, 73, 78, 79]

Professor and Director, The Ohio State University Comprehensive Cancer Center CEO, James Cancer Hospital and Solove Research Institute The Ohio State University Columbus, Ohio

Jaime Caro, MD [56]

Professor of Medicine Department of Medicine Thomas Jefferson University Cardeza Foundation for Hematologic Research Philadelphia, Pennsylvania

Jorge J. Castillo, MD [109]

Assistant Professor of Medicine Dana-Farber Cancer Institute Harvard Medical School Boston, Massachusetts

Bruce A. Chabner, MD [22]

Professor of Medicine Massachusetts General Hospital Cancer Center Harvard Medical School Boston, Massachusetts

Richard W. Childs, MD [77]

Clinical Director, NHLBI

Chief, Section of Transplantation Immunotherapy National Heart, Lung, and Blood Institute, NIH

Bethesda, Maryland

James M. Cleary, MD, PhD [22]

Instructor in Medicine

Dana-Farber Cancer Institute

Harvard Medical School

Boston, Massachusetts

Theresa L Coetzer, MD [46]

Head: Red Cell Membrane Unit

Department of Molecular Medicine and Haematology

National Health Laboratory Service

University of the Witwatersrand

Wits Medical School

Johannesburg, South Africa

Claudia S. Cohn, MD [138]

Assistant Professor, Laboratory Medicine and Pathology

University of Minnesota

Minneapolis, Minnesota

Barry S. Coller, MD [112, 120]

Allen and Frances Adler Laboratory of Blood and Vascular Biology

Physician-in-Chief

Vice President for Medical Affairs

The Rockefeller University

New York, New York

Gregory C. Connolly, MD [25]

Department of Medicine

Lipson Cancer Center

Rochester Regional Health System

Rochester, New York

Myra Coppage [137]

Associate Professor of Laboratory Medicine

Department of Pathology and Laboratory Medicine

University of Rochester

Rochester, New York

Michiel Coppens, MD, PhD [130]

Department of Vascular Medicine

Academic Medical Center

Amsterdam, The Netherlands

Francesca Cottini, MD [107]

Dana-Farber Cancer Institute

Boston, Massachusetts

Gay M. Crooks, MB, BS, FRACP [74]

Professor

Departments of Pathology & Laboratory Medicine and Pediatrics David Geffen School of Medicine

University of California, Los Angeles

Los Angeles, California

Adam Cuker, MD, MS [118]

Assistant Professor of Medicine & of Pathology and Laboratory Medicine

Perelman School of Medicine at the University of Pennsylvania Philadelphia, Pennsylvania

Yun Dai, MD [16]

Associate Professor of Medicine Department of Medicine

Massey Cancer Center

Virginia Commonwealth University

Richmond, Virginia

David C. Dale, MD [65]

Professor of Medicine

Department of Medicine

University of Washington

Seattle, Washington

Chi V. Dang, MD, PhD [14]

Professor and Director

Abramson Cancer Center

University of Pennsylvania

Philadelphia, Pennsylvania

Utpal P. Davé, MD [5]

Division of Hematology/Oncology

Department of Medicine

Vanderbilt University Medical Center

Nashville, Tennessee

Randy Daughters, PhD [30]

Assistant Professor

Department of Genetics

Cell Biology, and Development, Stem Cell Institute

University of Minnesota

Minneapolis, Minnesota

Philippe de Moerloose, MD [125]

Professor

Division of Angiology and Haemostasis

University of Geneva Faculty of Medicine

Geneva, Switzerland

Madhay Dhodapkar, MBBS [21]

Arthur H. and Isabel Bunker Professor of Medicine (Hematology) and Professor of Immunobiology

Chief, Section of Hematology, Department of Internal Medicine

Clinical Research Program Leader, Hematology Program

Yale Cancer Center

New Haven, Connecticut

Angela Dispenzieri, MD [108]

Division of Hematology

Mayo Clinic

Rochester, Minnesota

Reyhan Diz-Küçükkaya, MD [117]

Associate Professor Department of Internal Medicine Division of Hematology Istanbul University Istanbul Faculty of Medicine Istanbul, Turkey

Anne G. Douglas, BA [67, 68]

Student, Perelman School of Medicine University of Pennsylvania (Class of 2017) Philadelphia, Pennsylvania

Steven D. Douglas, MD [67, 68]

Professor and Associate Chair Department of Pediatrics Perelman School of Medicine University of Pennsylvania Children's Hospital of Philadelphia Philadelphia, Pennsylvania

Martin Dreyling, MD [100]

Department of Internal Medicine III Medical Center of the University of Munich Munich, Germany

Ann M. Dvorak, MD [63]

Senior Pathologist, Professor of Pathology Department of Pathology Beth Israel Deaconess Medical Center Harvard Medical School Boston, Massachusetts

Dustin Dzube, MD [22]

Resident Physician Massachusetts General Hospital Harvard Medical School Boston, Massachusetts

Yvonne A. Efebera, MD, MPH [78]

Associate Professor of Internal Medicine Division of Hematology Department of Internal Medicine The Ohio State University Columbus, Ohio

Deborah Elstein, PhD [72]

Gaucher Clinic Shaare Zedek Medical Center Jerusalem, Israel

William B. Ershler, MD [9]

Scientific Director Institute for Advanced Studies in Aging and Geriatrics Falls Church, Virginia

Miguel A. Escobar, MD [123]

Professor of Medicine and Pediatrics Division of Hematology University of Texas Health Science Center at Houston Director, Gulf States Hemophilia and Thrombophilia Center Houston, Texas

Andrew G. Evans, MD, PhD [102]

Assistant Professor Department of Pathology and Laboratory Medicine University of Rochester Medical Center Rochester, New York

Ross M. Fasano, MD [55]

Assistant Professor Emory University School of Medicine Departments of Pathology and Pediatric Hematology Assistant Director, Children's Healthcare of Atlanta Transfusion Services

Associate Director, Grady Health System Transfusion Service Atlanta, Georgia

Charles W. Francis, MD [25]

Hematology/Oncology Division University of Rochester Medical Center Rochester, New York

Aharon G. Freud, MD, PhD [6, 94]

Assistant Professor Department of Pathology The Ohio State University Columbus, Ohio

Jonathan W. Friedberg, MD [102]

Samuel Durand Professor of Medicine Director, Wilmot Cancer Institute University of Rochester Medical Center Rochester, New York

Hua Fung, MD [29]

Case Western Reserve University University Hospital of Cleveland Cleveland, Ohio

Stephen J. Galli, MD [63]

Mary Hewitt Loveless, MD, Professor Professor of Pathology and of Microbiology and Immunology Chair, Department of Pathology Stanford University School of Medicine Stanford University Medical Center Stanford, California

Tomas Ganz, MD, PhD [37, 42, 43]

Departments of Medicine and Pathology, David Geffen School of Medicine University of California, Los Angeles Los Angeles, California

Randy D. Gascoyne, MD, FRCPC [96]

Clinical Professor of Pathology
Research Director, Centre for Lymphoid Cancers
Departments of Pathology and Advanced Therapeutics British
Columbia Cancer Agency, the BC Centre Research Center and
University of British Columbia
Vancouver, British Columbia, Canada

Terry B. Gernsheimer, MD [139]

Professor of Medicine Department of Medicine, Division of Hematology University of Washington School of Medicine Seattle Cancer Care Alliance Seattle, Washington

Stanton Gerson, MD [29]

Director, Case Comprehensive Cancer, Seidman Cancer Center & National Center for Regenerative Medicine Distinguished University Professor Case Western Reserve University University Hospital of Cleveland Cleveland, Ohio

Morie A. Gertz, MD, MACP [108]

Division of Hematology Mayo Clinic Rochester, Minnesota

Larisa J. Geskin, MD, FAAD [103, 105]

Associate Professor of Dermatology and Medicine
Director, Division of Cutaneous Oncology and Comprehensive Skin
Cancer Center
Department of Dermatology
Columbia University
New York, New York

David Ginsburg, MD [126]

Professor, Department of Internal Medicine, Human Genetics and Pediatrics Investigator, Howard Hughes Medical Institute Life Sciences Institute

University of Michigan Ann Arbor, Michigan

Lucy A. Godley, MD, PhD [13]

Section of Hematology/Oncology
Department of Medicine and The University of Chicago
Comprehensive Cancer Center
The University of Chicago
Chicago, Illinois

Steven Grant, MD [16]

Professor of Medicine and Biochemistry Shirley and Sture Gordon Olsson Professor of Oncology Associate Director Translational Research, Massey Cancer Center Virginia Commonwealth University Health Sciences Center Richmond, Virginia

Anthony R. Green, PhD, FRCP, FRCPath, FMedSci [85]

Professor of Haematology Cambridge Institute for Medical Research and Stem Cell Institute University of Cambridge Cambridge, United Kingdom

Ralph Green, MD, PhD, FRCPath [41, 44]

Professor of Pathology and Medicine University of California Davis Medical Center Sacramento, California

Xylina T. Gregg, MD [38]

Director of Laboratory Services Utah Cancer Specialists Salt Lake City, Utah

Michael R. Grever, MD [93]

Chair and Professor
Department of Internal Medicine
Bertha Bouroncle MD and Andrew Pereny Chair in Medicine
The Ohio State University
Columbus, Ohio

John Gribben, MD, DSc, FRCP, FRCPath, FMedSci [76]

Chair of Medical Oncology Barts Cancer Institute Centre for Haemato-Oncology Queen Mary University of London London, United Kingdom

John H. Griffin, PhD [114]

Professor Department of Molecular and Experimental Medicine The Scripps Research Institute La Jolla, California

Katherine A. Hajjar, MD [115, 135] Professor of Pediatrics

Brine Family Professor, Department of Cell and Developmental Biology Professor of Medicine Well Cornell Medical College Attending Pediatrician New York Presbyterian Hospital

Robert D. Harrington, MD [81]

Professor of Medicine University of Washington Seattle, Washington

New York, New York

Jeanne E. Hendrickson, MD [55]

Associate Professor Departments of Laboratory Medicine and Pediatrics Yale University School of Medicine New Haven, Connecticut

Paul C. Herrmann, MD, PhD [52]

Associate Professor and Chair Department of Pathology and Human Anatomy Loma Linda University School of Medicine Loma Linda, California

Steven Horwitz, MD [104]

Department of Medicine Memorial Sloan Kettering Cancer Center New York, New York

Annie L. Hsieh, MD [14]

Department of Pathology Johns Hopkins University, School of Medicine Baltimore, Maryland

Zachary R. Hunter, PhD [109]

Bing Center for Waldenstrom's Macroglobulinemia Dana-Farber Cancer Institute Instructor of Medicine, Harvard Medical School Boston, Massachusetts

Russell D. Hull, MD [133]

Professor
Department of Medicine
University of Calgary
Active Staff
Department of Internal Medicine
Foothills Hospital
Calgary, Alberta, Canada

Achille Iolascon, MD, PhD [39]

Professor of Medical Genetics Dept. of Molecular Medicine and Medical Biotechnologies University Federico II of Naples Naples, Italy

Joseph E. Italiano Jr., PhD [112]

Associate Professor of Medicine Brigham and Women's Hospital Harvard Medical School Boston, Massachusetts

Benjamin Izar, MD, PhD [22]

Post-doctoral Scientist Dana-Farber Cancer Institute and Broad Institute Associate Physician, Brigham and Women's Hospital Harvard Medical School Boston, Massachusetts

Siegfried Janz, MD, DSc [105]

Division of Hematology/Oncology & Blood and Marrow Transplantation Department of Pathology, Carver College of Medicine University of Iowa Health Care Iowa City, Iowa

Jill M. Johnsen, MD [126]

Assistant Member, Research Institute Bloodworks Northwest Puget Sound Blood Center Assistant Professor, Division of Hematology Department of Medicine University of Washington Seattle, Washington

Lynn B. Jorde, PhD [10]

H. A. and Edna Benning Presidential Professor Department of Human Genetics University of Utah School of Medicine Salt Lake City, Utah

Bindu Kanapuru, MD [9]

Institute for Advanced Studies in Aging and Geriatrics Falls Church, Virginia

Kenneth Kaushansky, MD, MACP [17, 18, 111, 116, 119]

Senior Vice President, Health Sciences Dean, School of Medicine SUNY Distinguished Professor Stony Brook Medicine State University of New York Stony Brook, New York

Nigel S. Key, MB, ChB, FRCP [123]

Harold R. Roberts Distinguished Professor of Medicine Director, University of North Carolina Hemophilia and Thrombosis Center Chapel Hill, North Carolina

Thomas J. Kipps, MD, PhD [75]

Evelyn and Edwin Tasch Chair in Cancer Research Professor of Medicine Division of Hematology/Oncology Deputy Director for Research Operations Moores UCSD Cancer Center University of California, San Diego La Jolla, California

Mark J. Koury, MD [5]

Division of Hematology/Oncology Department of Medicine Vanderbilt University Medical Center Nashville, Tennessee

Abdullah Kutlar, MD [49]

Professor of Medicine Georgia Sickle Cell Center Medical College of Georgia Sickle Cell Center Augusta, Georgia

Robert A. Kyle, MD [110,]

Professor of Medicine Laboratory Medicine and Pathology Mayo Clinic Rochester, Minnesota

Lewis L. Lanier, PhD [77]

Professor Department of Microbiology and Immunology University of California, San Francisco San Francisco, California

Richard A. Larson, MD [91]

Section of Hematology/Oncology Department of Medicine and the Comprehensive Cancer Center University of Chicago Chicago, Illinois

Michelle M. Le Beau, PhD [13]

Section of Hematology/Oncology Department of Medicine and the Center Research Center University of Chicago Chicago, Illinois

Frank W.G. Leebeek, MD, PhD [128]

Professor of Hematology Department of Hematology Erasmus University Medical Center Rotterdam, The Netherlands

Marcel Levi, MD, PhD [116, 122, 129]

Department of Medicine/Vascular Medicine Academic Medical Center University of Amsterdam Amsterdam, The Netherlands

Marshall A. Lichtman, MD [1, 35, 53, 64, 69, 70, 83, 86, 88, 89, 95, 106]

Professor of Medicine and of Biochemistry and Biophysics University of Rochester Medical Center Rochester, New York

Jane L. Liesveld, MD [88, 89]

Professor of Medicine (Hematology-Oncology) James P. Wilmot Cancer Institute University of Rochester Medical Center Rochester, New York

Ton Lisman, PhD [128]

Professor of Experimental Surgery
Surgical Research Laboratory and Section of Hepatobiliary Surgery
and Liver Transplantation
Department of Surgery
University Medical Center, Groningen
Groningen, The Netherlands

John S. (Pete) Lollar III, MD [127]

Aflac Cancer Center and Blood Disorders Services Department of Pediatrics Emory University Atlanta, Georgia

Christine Lomas-Francis, MSc, FIBMS [136]

Technical Director Laboratory of Immunohematology and Genomics New York Blood center New York, New York

José A. Lópéz, MD [117]

Chief Scientific Officer Bloodworks Northwest Professor of Medicine and Biochemistry University of Washington Seattle, Washington

Robert Lowsky, MD [23]

Division of Blood and Marrow Transplantation Stanford University Stanford, California

Gerard Lozanski, MD [93]

Director, Hematopathology Medical Director Flow Cytometry Laboratory Associate Professor—Clinical Department of Pathology The Ohio State University Columbus, Ohio

Naomi L. C. Luban, MD [55]

Professor, Pediatrics and Pathology George Washington University Medical Center Division Chief, Laboratory Medicine Director, Transfusion Medicine/Donor Center Children's National Medical Center Washington, D.C.

Crystal L. Mackall, MH [21]

Head, Immunology Section and Chief, Pediatric Oncology Branch National Cancer Institute Bethesda, Maryland

Aaron J. Marcus, MD* [115]

Professor of Medicine Weill Cornell Medical College Attending Physician New York Harbor Healthcare System New York, New York

Elaine R. Mardis, PhD [11]

Robert E. and Louise F. Dunn Distinguished Professor of Medicine Co-director, The Genome Institute, Division of Genomics and Bioinformatics, Department of Medicine, Washington University School of Medicine

Siteman Cancer Center, Washington University School of Medicine Saint Louis, Missouri

Fabienne McClanahan, MD, PhD [76]

Barts Cancer Institute Centre for Haemato-Oncology Queen Mary University of London London, United Kingdom

Kenneth L. McClain, MD, PhD [71]

Professor of Pediatrics Texas Children's Cancer Center/Hematology Baylor College of Medicine Houston, Texas

Jeffrey McCullough, MD [138]

Professor

Department of Laboratory Medicine and Pathology American Red Cross Professor, Transfusion Medicine University of Minnesota Medical School Minneapolis, Minnesota

Janice McFarland, MD [137]

Blood Center of Southeast Wisconsin Milwaukee, Wisconsin

Shannon L. Meeks, MD [127]

Aflac Cancer Center and Blood Disorders Services Department of Pediatrics Emory University Atlanta, Georgia

^{*}Deceased