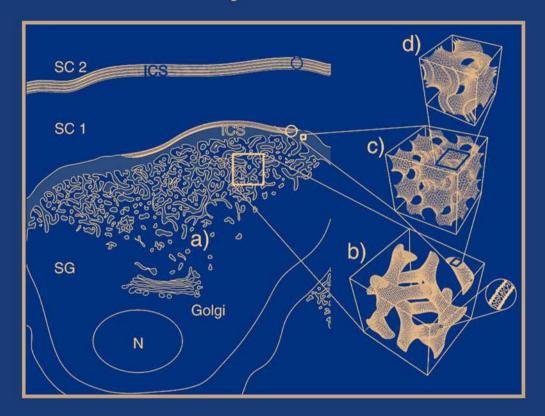
DRY SKIN and MOISTURIZERS

Chemistry and Function



Edited by Marie Lodén Howard I. Maibach

DERMATOLOGY: CLINICAL & BASIC SCIENCE SERIES



DRY SKIN and MOISTURIZERS

Chemistry and Function

SECOND EDITION

DERMATOLOGY: CLINICAL & BASIC SCIENCE SERIES

Series Editor Howard I. Maibach, M.D.

Published Titles:

Bioengineering of the Skin: Cutaneous Blood Flow and Erythema

Enzo Berardesca, Peter Elsner, and Howard I. Maibach

Bioengineering of the Skin: Methods and Instrumentation

Enzo Berardesca, Peter Elsner, Klaus P. Wilhelm, and Howard I. Maibach

Bioengineering of the Skin: Skin Biomechanics

Peter Elsner, Enzo Berardesca, Klaus-P. Wilhelm, and Howard I. Maibach

Bioengineering of the Skin: Skin Surface, Imaging, and Analysis

Klaus P. Wilhelm, Peter Elsner, Enzo Berardesca, and Howard I. Maibach

Bioengineering of the Skin: Water and the Stratum Corneum, Second Edition

Peter Elsner, Enzo Berardesca, and Howard I. Maibach

Contact Urticaria Syndrome

Smita Amin, Arto Lahti, and Howard I. Maibach

Cutaneous T-Cell Lymphoma: Mycosis Fungoides and Sezary Syndrome

Herschel S. Zackheim and Howard I. Maibach

Dermatologic Botany

Javier Avalos and Howard I. Maibach

Dermatologic Research Techniques

Howard I. Maibach

Dry Skin and Moisturizers: Chemistry and Function, Second Edition

Marie Lodén and Howard I. Maibach

The Epidermis in Wound Healing

David T. Rovee and Howard I. Maibach

Hand Eczema, Second Edition

Torkil Menné and Howard I. Maibach

Human Papillomavirus Infections in Dermatovenereology

Gerd Gross and Geo von Krogh

The Irritant Contact Dermatitis Syndrome

Pieter van der Valk, Pieter Coenrads, and Howard I. Maibach

Latex Intolerance: Basic Science, Epidemiology, and Clinical Management

Mahbub M. V. Chowdhry and Howard I. Maibach

Nickel and the Skin: Absorption, Immunology, Epidemiology, and Metallurgy

Jurij J. Hostýneck and Howard I. Maibach

Pesticide Dermatoses

Homero Penagos, Michael O'Malley, and Howard I. Maibach

Protective Gloves for Occupational Use, Second Edition

Anders Boman, Tuula Estlander, Jan E. Wahlberg, and Howard I. Maibach

Skin Cancer: Mechanisms and Human Relevance

Hasan Mukhtar

Skin Reactions to Drugs

Kirsti Kauppinen, Kristiina Alanko, Matti Hannuksela, and Howard I. Maibach

DRY SKIN and MOISTURIZERS

Chemistry and Function

SECOND EDITION

Edited by Marie Lodén, Dr. Med. Sci. Howard I. Maibach, M.D.



Published in 2006 by CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

© 2006 by Taylor & Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group

No claim to original U.S. Government works Printed in the United States of America on acid-free paper 10 9 8 7 6 5 4 3 2 1

International Standard Book Number-10: 0-8493-2134-4 (Hardcover) International Standard Book Number-13: 978-0-8493-2134-4 (Hardcover) Library of Congress Card Number 2005047810

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the author and the publisher cannot assume responsibility for the validity of all materials or for the consequences of their use.

No part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (http://www.copyright.com/) or contact the Copyright Clearance Center, Inc. (CCC) 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Library of Congress Cataloging-in-Publication Data

Dry skin and moisturizers: chemistry and function / edited by Marie Lodén, Howard L. Maibach.--2nd ed.

p.; cm. -- (Dermatology: clinical and basic science series; 27)

Includes bibliographical references and index.

ISBN 0-8493-2134-4 (alk. paper)

1. Dermatologic agents. 2. Skin--Diseases. 3. Barrier creams. 4. Wetting agents. I. Lodén, Marie II. Maibach, Howard I. III. Dermatology (CRC Press); 27.

[DNLM: 1. Skin Diseases--drug therapy. 2. Emollients--pharmacokinetics. 3. Emollients--therapeutic use. 4. Skin Diseases--physiopathology. WR 650 D798 2005]

RL801.D79 2005 616.5'061--dc22

2005047810



Visit the Taylor & Francis Web site at http://www.taylorandfrancis.com and the CRC Press Web site at http://www.crcpress.com

Preface

In the five years since the first edition of this book was published, there has been an explosion in new information relating to the nature of dry skin and its treatment. Investigators from various disciplines, including dermatologists, pharmacists, chemists, biochemists, molecular biologists, physiologists, pharmacologists, and even psychologists have advanced our knowledge tremendously. We now understand that the stratum corneum has a surprisingly large number of functions in maintaining the physiologic stability and homeostasis of the skin and mind. This second revised and updated edition of *Dry Skin and Moisturizers* is therefore timely and most welcomed.

Our quality of life is influenced not only by the appearance and tactile feel of the skin surface, but also by the sensorial feelings inside the skin. The generic term "dry skin" denotes a diverse family of conditions with a variety of pathologies preceding each one of them. We also recognize the complex interactions between topically applied substances and the skin.

The chapters in this volume provide information to the health care professionals who would like to increase their knowledge about dry skin disorders and learn more about the effects of constituents in moisturizing creams and pharmaceutical preparations. Moreover, the pharmaceutical and cosmetic industry will find information for an improved tailoring of moisturizers according to the underlying skin abnormality. Regulatory and safety issues are also covered. Furthermore, experienced researchers will get inspiring and fruitful ideas due to the easily accessible information about neighboring research areas, which will promote new discoveries. Readers who wish to go deeper into topics in which they have a special interest are able to do so via the numerous references provided.

We are indebted to the 60 renowned international specialists who have contributed excellent chapters for the book. We sincerely hope that you will enjoy reading the book as much as we have enjoyed planning and receiving the chapters from these authors. Suggestions for improvements for coming editions are appreciated.

We also wish to express our appreciation to Ms Erica Dery and Ms Helena Redshaw at CRC Press for accelerating the editorial process.

Marie Lodén Howard I. Maibach

Editors

Marie Lodén, Pharm., Dr. Med. Sc., Assoc. Professor, is head of Research and Development for the dermatological company ACO Hud AB, in Stockholm, Sweden. She obtained her pharmacist degree in 1980 from Uppsala University, received her doctoral degree in Medical Science in 1995, and began her dermatological research with chemical warfare agents at the National Defense Research Institute. She assumed her present position in 1992. Dr. Lodén was appointed associate professor in experimental dermatology at Uppsala University in 2005.

Dr. Lodén is a member of several national and international societies such as the International Society for Bioengineering and the Skin, and acts in the Committee of the European Group of Efficacy Measurements of Cosmetics and Other Topical Products (EEMCO) and the Scandinavian Society of Cosmetic Chemists (SCANCOS). She is also a member of the editorial board of the *International Journal of Cosmetic Science*.

Dr. Lodén's major research interests are skin barrier function, contact dermatitis, skin care, biophysical measurements, and toxicology. She has published almost 70 original papers and book chapters.

Howard Maibach, M.D., is a professor of dermatology at the University of California, San Francisco and has been a long-term contributor to experimental research in dermatopharmacology and to clinical research on contact dermatitis, contact urticaria, and other skin conditions.

Contributors

Martin Albrecht

Kuhs GmbH & Co. KG Leichlingen, Germany

K.P. Ananthapadmanabhan

Claims Development Unilever Global Technology Center Trumbull, Texas

David Basketter

Unilever Environmental Safety Laboratory Colworth House, Sharnbrook, UK

Enzo Berardesca

San Gallicano Dermatological Institute Rome, Italy

Ying L. Boissy

Miami Valley Laboratories Proctor and Gamble Corporation Cincinnati, Ohio

Maria Breternitz

Skin Physiology Laboratory Department of Dermatology and Allergology Friedrich Schiller University Jena Jena, Germany

Izabela Buraczewska

ACO Hud AB Research and Development Upplands Väsby, Sweden

Ai-Lean Chew

Department of Dermatology, University of California San Francisco, California

Karen Cooper

Unilever Environmental Safety Laboratory Colworth House, Sharnbrook, UK

Heather L. Daughters

Department of Dermatology, University of California San Francisco, California

Mitsuhiro Denda

Shiseido Reseach Center Yokohama, Japan

Frank Dreher

Neocutis, Inc. San Francisco, California

Torbjörn Egelrud

Department of Dermatology University Hospital Umeå, Sweden

Keith Ertel

Miami Valley Laboratories Proctor and Gamble Corporation Cincinnati, Ohio

Joachim W. Fluhr

Skin Physiology Laboratory
Department of Dermatology and Allergology
Friedrich Schiller University Jena
Jena, Germany

Bernard Gabard

Egerkingen, Switzerland

Anke Gauger

Klinik und Poliklinik für Dermatologie und Allergologie am Biederstein Technische Universität München München, Germany

Miklos Ghyczy

Cologne, Germany

Norm V. Gitis

Center for Tribology, Inc. Campbell, California

Harald P.M. Gollnick

Clinic Dermatology & Venereology Otto-von-Guericke University Magdeburg, Germany

An Goosens

Department of Dermatology University Hospital Leuven, Belgium

Ian Harris

Beiersdorf AG Hamburg, Germany

Udo Hoppe

Heidmühlen, Germany

Xinfan Huang

GenePharm, Inc. Sunnyvale, California

Soeren Jaspers

Beiersdorf AG Hamburg, Germany

Gregor B.E. Jemec

Divison of Dermatology Department of Medicine Roskilde, Denmark

Albert Kligman

Department of Dermatology University of Pennsylvania Philadelphia, Pennsylvania

Ludger Kolbe

Beiersdorf AG Hamburg, Germany

Andrea Krautheim

Clinic Dermatology and Venereology Otto-von-Guericke University Magdeburg, Germany

Raj Lad

Genecor

Palo Alto, California

Jean-Luc Leveque

L'Oreal Clichy, France

Magnus Lindberg

Department of Occupational and Environmental Dermatology Stockholm, Sweden

Marie Lodén

ACO HUD AB

Research and Development Upplands Väsby, Sweden

Marie Marriott

Unilever Environmental Safety Laboratory Colworth House, Sharnbrook, UK

David S. Morrison

Penreco

The Woodlands, Texas

Greg Nole

Claims Development Unilever Global Technology Center Trumbull, Texas

Lars Norlén

Karolinska University Hospital Stockholm, Sweden

Jan Pallon

Department of Occupational and Environmental Dermatology Stockholm, Sweden

Lisa Peters

Unilever Environmental Safety Laboratory Colworth House, Sharnbrook, UK

G.E. Piérard

Department of Dermatopathology, University Hospital Sart Tilman, Liège, Belgium

Claudine Piérard-Franchimont

Department of Dermatopathology, University Hospital Sart Tilman, Liège, Belgium

Ehrhardt Proksch

Department of Dermatology University of Kiel Kiel, Germany

Anthony V. Rawlings

Clive Harding Unilever Research Colworth House Laboratory Sharnbrook, UK

Leslev E. Rhodes

Dermatology Centre University of Manchester Manchester, UK

Raja K. Sivamani

Department of Dermatology School of Medicine University of California San Francisco, California

Robert Stern

Department of Pathology School of Medicine University of California San Francisco San Francisco, California

Amy Storey

Department of Medicine University of Liverpool Liverpool, UK

K. Subramanyan

Claims Development Unilever Global Technology Center Trumbull, Texas

Brett T. Summey

Department of Dermatology Wake Forest University School of Medicine Medical Center Boulevard Winston Salem, North Carolina

Christian Surber

Institute of Hospital Pharmacy Department of Dermatology University of Basel Basel, Switzerland

Motoji Takahashi

Shiseido Research Center Yokohama, Japan

Monica Tammela

Medical Products Agency Uppsala, Sweden

Hanafi Tanojo

GenePharm, Inc. Sunnyvale, California

Emmanuelle Uhoda

Department of Dermatopathology University Hospital Sart Tilman Liège, Belgium

Anders Vahlquist

Department of Dermatology and Venereology University Hospital Uppsala, Sweden

Vladimir Vacata

Bonn, Germany

Hisashi Wakita

Division of Dermatology Toyosato Hospital Shigaken, Japan

Ronald R. Warner

Miami Valley Laboratories Proctor and Gamble Corporation Cincinnati, Ohio

Philip W. Wertz

Marshall Research Laboratories Department of Dermatology University of Iowa College of Medicine Coralville, Iowa

Gabriel Wu

Department of Dermatology School of Medicine University of California San Francisco, California

Gil Yosipovitch

Department of Dermatology Wake Forest University School of Medicine Medical Center Boulevard Winston Salem, North Carolina

Contents

Chapter I	Albert Kligman	1
I The Ski	i n	5
Bioche	mistry and Function	7
Chapter 2	The Skin as a Barrier Magnus Lindberg and Bo Forslind	9
Chapter 3	Epidermal Lipids and Formation of the Barrier of the Skin <i>Philip W. Wertz</i>	23
Chapter 4	Lipid Structures in the Permeability Barrier Lars Norlén	31
Chapter 5	Particle Probes and Skin Physiology Jan Pallon, Bo Forslind, and Magnus Lindberg	43
Chapter 6	Role of Calcium Ions in the Regulation of Skin Barrier Homeostasis Hanafi Tanojo, Xinfan Huang, and Howard I. Maibach	63
Chapter 7	Desquamation Torbjörn Egelrud	71
Dry Sk	in and Hyperkeratotic Conditions	81
Chapter 8	Ichthyosis — An Inborn Dryness and Scaliness of the Skin Anders Vahlquist	83
Chapter 9	Dry Skin in Atopic Dermatitis and Patients on Hemodialysis Motoji Takahashi and Zenro Ikezawa	95
Chapter 10	Experimentally Induced Dry Skin Mitsuhiro Denda	107
Chapter 11	Dryness in Chronologically and Photo-Aged Skin Ehrhardt Proksch	117

Chapter 12	Itch Associated with Dryness of the Skin: the Pathophysiology and Influence of Moisturizers Brett T. Summey Jr. and Gil Yosipovitch	127
Chapter 13	Effects of Moisturizer in Psoriasis Joachim W. Fluhr, Maria Breternitz, and Enzo Berardesca	135
II Formu	lations	145
Interac	ctions with the Skin	147
Chapter 14	Moisturizers as a Medical, Biological, Psychological, Cultural, and Economic Factor <i>Gregor B.E. Jemec</i>	149
Chapter 15	New Methodology to Improve Epidermal Barrier Homeostasis Mitsuhiro Denda	155
Chapter 16	Outside and Inside Skin pH Izabela Buraczewska	161
Chapter 17	Dry Skin and Use of Proteases A.V. Rawlings and R. Lad	171
Chapter 18	Effects of Natural Moisturizing Factor and Lactic Acid Isomers on Skin Function Clive R. Harding and Anthony V. Rawlings	187
Chapter 19	Clinical Evidence for the Use of Urea Marie Lodén	211
Chapter 20	Glycerol — Just a Moisturizer? Biological and Biophysical Effects Joachim W. Fluhr, Anja Bornkessel, and Enzo Berardesca	227
Chapter 21	Hyaluronan: Key to Skin Moisture Robert Stern	245
Chapter 22	Hydrophilic Pastes Bernard Gabard and Christian Surber	279
Chapter 23	Petrolatum David S. Morrison	289
Chapter 24	Phospholipids, Metabolites, and Skin Hydration Miklos Ghyczy, Martin Albrecht, and Vladimir Vacata	299
Chapter 25	Lanolins Ian Harris and Udo Hoppe	309

Chapter 26	Essential Fatty Acids: Biological Functions and Potential Applications in the Skin Lesley Elizabeth Rhodes and Amy Storey	319
Chapter 27	Sphingolipids: from Chemistry to Possible Biologic Influence on the Skin <i>Hisashi Wakita</i>	341
Chapter 28	Effect of Moisturizers on the Structure of Lipids in the Outer Stratum Corneum of Humans Keith D. Ertel, Ronald R. Warner, and Ying L. Boissy	351
Chapter 29	Vitamins and Skin Krautheim A. and Gollnick H.P.M.	375
Chapter 30	Antimicrobials Anke Gauger	391
Chapter 31	Moisturizing Cleansers K.P. Ananthapadmanabhan, K. Subramanyan, and Greg Nole	405
III Skin I	Measurements	429
Chapter 32	Tribological Studies on Skin: Measurement of the Coefficient of Friction Raja K. Sivamani, Gabriel, W.u., Norm V. Gitis, and Howard I. Maibach	431
Chapter 33	Smoothness of the Skin, Complexity, and Instrumental Approach Jean Luc Lévêque	443
Chapter 34	Assessment of Skin Moisturization with Electrical Methods Enzo Berardesca	451
Chapter 35	Stratum Corneum Tape Stripping: Relationship with Dry Skin and Moisturizers Frank Dreher and Howard I. Maibach	457
Chapter 36	XLRS Squamometry Revisited Emmanuelle Uhoda, Claudine Piérard-Franchimont, and G.E. Piérard	465
Chapter 37	Methods for Testing Stratum Corneum Barrier Properties <i>Ludger Kolbe and Soeren Jaspers</i>	475
IV Skin I	Reactions	485
Chapter 38	Sensitive Skin Heather L. Daughters, Ai-Lean Chew, and Howard I. Maibach	487
Chapter 39	Stinging and Irritating Substances: Their Identification and Assessment Karen Cooper, Marie Marriott, Lisa Peters, and David Basketter	501

Chapter 40	Sensitizing Substances A.E. Goossens	515
Chapter 41	Regulatory Aspects on Safety Monica Tammela	523
Index		531