BIOACTIVE COMPONENTS OF HUMAN MILK

Edited by

David S. Newburg

Shriver Center
Waltham, Massachusetts
and Harvard Medical School
Boston, Massachusetts

Kluwer Academic/Plenum Publishers
New York, Boston, Dordrecht, London, Moscow
Bioactive components of human milk edited by David S. Newburg.

p. cm. — (Advances in experimental medicine and biology; v. 501)
Includes bibliographical references and index.
ISBN 0-306-46653-8

QP246 .B625 2001
612.6'64—dc21


ISBN 0-306-46653-8

233 Spring Street, New York, N.Y. 10013

http://www.kap.nl/

10 9 8 7 6 5 4 3 2 1

A C.I.P. record for this book is available from the Library of Congress

All rights reserved

No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the Publisher

Printed in the United States of America
CONTENTS

SECTION I. INTRODUCTION

1. Bioactive components of human milk: Evolution, efficiency, and protection ........................................... 3
   David S Newburg

2. Human milk and the response of intestinal epithelium to infection . . . 11
   Kathrin Bernt and W Allan Walker

Introduction to the Macy-György award lecture ...................... 31
   David S Newburg

3. MUC1 and MUC-X, epithelial mucins of breast and milk ............ 35
   Stuart Patton

4. Drug transport into milk ........................................... 47
   Patrick J McNamara

SECTION II. HORMONES AND GROWTH FACTORS IN MAMMARY DEVELOPMENT AND IN MILK

Overview: Hormones and growth factors ................................ 59
   David S Newburg

5. The transforming growth factors beta in development and functional differentiation of the mouse mammary gland .......... 61
   Charles W Daniel, Stephen Robinson, and Gary B Silberstein

6. Is milk a conduit for developmental signals? ....................... 71
   Kevin D Nusser and L Stephen Frawley

7. Regulation of cell apoptosis by insulin-like growth factor I ........ 79
   Darryl L Hadsell and Ghada Abdel-Fattah
8. Human milk contains detectable levels of immunoreactive leptin
   Robert E Lyle, Stephen C Kincaid, Janet C Bryant, Audra M Prince, and Robert E McGehee Jr

9. Induction of expression of branched-chain aminotransferase and alpha-keto acid dehydrogenase in rat tissues during lactation
   Soledad DeSantiago, Nimbe Torres, Susan Hutson, and Armando R Tovar

10. A low-fat diet but not food restriction improves lactational performance in obese rats
    Kathleen M Rasmussen, Mary H Wallace, and Effie Gournis

11. Human lactoferrin in the milk of transgenic mice increases intestinal growth in ten-day-old suckling neonates
    P Zhang, V Sawicki, A Lewis, L Hanson, JH Nuijens, and MC Neville

12. Growth rates of a human colon adenocarcinoma cell line are regulated by the milk protein alpha-lactalbumin
    Lisa G Sternhagen and Jonathan C Allen

SECTION III. MILK LIPIDS AND THE MILK FAT GLOBULE

Overview: Milk lipids
   David S Newburg

13. Assembly and secretion of the lipid globules of milk
    Thomas W Keenan

14. Prolonged breast-feeding (six months or more) and milk fat content at six months are associated with higher developmental scores at one year of age within a breast-fed population
    C Agostoni, F Marangoni, M Giovannini, C Galli, and E Riva

15. Presence of carotenoid, an anticarcinogenic marker, in nipple aspirates postlactation
    Chandice Covington, Anne Mitchell-Gieleghem, David Lawson, Isao Eto, and Clinton Grubbs

16. The anticarcinogenic conjugated fatty acid c9, t11-C18:2, or rumenic acid, in human milk: Amounts and effects
    Robert G Jensen and Carol Lammi-Keefe

17. Long-chain polyunsaturated fatty acid concentrations in human hindmilk are constant throughout twelve months of lactation
    C Agostoni, F Marangoni, AM Lammardo, C Galli, M Giovannini, and E Riva
18. Parenteral infusion of a lactating woman with intralipid: Changes in milk and plasma fatty acids
Robert G Jensen, Carol J Lammi-Keefe, Maureen MacBurney, and Vasuki Wijendran

19. Investigation of long-chain polyunsaturated fatty acid metabolism in lactating women by means of stable isotope techniques
H Demmelmaier, M Baumheuer, B Koletzko, K Dokoupil, and G Kratl

20. Structural and functional aspects of three major glycoproteins of the human milk fat globule membrane
Jerry A Peterson, Ciaran D Scallan, Roberto L Ceriani, and Margit Hamosh

21. Anti-infectious properties of the human milk fat globule membrane
H Schroten, M Bosch, R Nobis-Bosch, H Koehler, F-G Hanisch, and R Plogmann

SECTION IV. IMMUNOMODULATORY AND ANTI-INFLAMMATORY AGENTS IN MILK

Overview: Immunomodulatory and anti-inflammatory agents
David S Newburg

22. Homeostasis of the mucosal immune system: Human milk and lactation
Jiri Mestecky

23. Anti-inflammatory characteristics of human milk: How, where, why
E Stephen Buescher

24. Development of a topical vaginal microbicide: Lessons learned from human milk
Charles E Isaacs, Raju Pullarkat, and Richard Kacsak

25. Does human lactoferrin in the milk of transgenic mice deliver iron to suckling neonates?
Linda H Hanson, Valerie Sawicki, Andrew Lewis, Jan H Nuijens, Margaret C Neville, and Peifang Zhang

26. Changes in lactoferrin and lysozyme levels in human milk during the first twelve weeks of lactation
P Montagne, ML Cuilliere, C Molé, MC Béné, and G Faure

27. The association of allergic sensitization in mother and child in breast-fed and formula-fed infants
Anne L Wright, Debra A Stern, and Marilyn Halonen
28. Vesicular transport of soluble substances into mouse milk .......................... 257
   Jenifer Monks and Margaret C Neville

SECTION V. NONANTIBODY IMMUNE FACTORS

Overview: Oligosaccharides and other protective components .................. 267
   David S Newburg

29. Glycoconjugates in human and transgenic animal milk ........................ 269
   B Kelder, R Erney, John Kopchick, Richard Cummings, and Pedro Prieto

30. Mass spectrometric investigations of human milk oligosaccharides ....... 279
   Anja Pfenninger, M Karas, B Finke, B Stahl, and G Sawatzki

31. Human milk oligosaccharides: A novel method provides insight into human genetics ................................................................. 285
   R Erney, M Hilty, Larry Pickering, Guillermo Ruiz-Palacios, and Pedro Prieto

32. Detection of four human milk groups with respect to Lewis-blood-group- dependent oligosaccharides by serologic and chromatographic analysis ............................................................... 299
   B Stahl, S Thurl, J Henker, M Siegel, B Finke, and G Sawatzki

33. Characterization of oligosaccharides in milk and feces of breast-fed infants by high-performance anion-exchange chromatography ............ 307
   GV Coppa, P Pierani, L Zampini, S Bruni, I Carloni, and O Gabrielli

34. Survival of human milk oligosaccharides in the intestine of infants ...... 315
   Prasoon Chaturvedi, Christopher D Warren, Christine R Buescher, Larry K Pickering, and David S Newburg

35. Comparison of oligosaccharides in milk specimens from humans and twelve other species ................................................................. 325
   Christopher D Warren, Prasoon Chaturvedi, Adrienne R Newburg, Olav T Oftedal, Christopher D Tilden, and David S Newburg

36. Human milk lipids bind Shiga toxin ..................................................... 333
   Irene Herrera-Insua, Henry F Gomez, Vicente A Diaz-Gonzalez, Prasoon Chaturvedi, David S Newburg, and Thomas G Cleary

37. Human milk antibacterial factors: The effect of temperature on defense systems ................................................................. 341
   Hann-Yi Chen and Jonathan C Allen
SECTION VI. CONDITIONALLY ESSENTIAL NUTRIENTS

Overview: Conditionally essential nutrients: Long-chain polyunsaturated fatty acids ......................................................... 351
Marcello Giovannini

Overview: Conditionally essential nutrients: Can long-chain polyunsaturated fatty acids and nucleotides qualify? ..................... 357
Margit Hamosh

38. Biotherapeutic agents and disease in infants ........................................ 365
Larry K Pickering

Robert A Gibson and Maria Makrides

40. Specific IgA to lactic acid bacteria in feces of children consuming milk fermented by yoghurt symbiosis and Lactobacillus casei (Danone strain DN 114 001) ............................................. 385
GC Faure, M Morisset, B Gobert, C Guérin, C Pedone, C Bouley, and MC Béné

41. Are breast-fed infants vitamin K deficient? .................................... 391
Frank R Greer

42. Long-chain polyunsaturated fatty acids (LC-PUFA) during early development: Contribution of milk LC-PUFA to accretion rates varies among organs ............................................................ 397
Margit Hamosh, Theresa R Henderson, Margaret A Kemper, Nicole M Orr, Amaryllis Gil, and Paul Hamosh

43. Gastric proteolysis in preterm infants fed mother’s milk or formula .... 403
Theresa R Henderson, Margit Hamosh, Martine Armand, Nitin R Mehta, and Paul Hamosh

44. Macronutrients in milk from mothers delivering preterm ................. 409
Jan Faerk, Lisbeth Skafte, Sten Petersen, Birgit Peitersen, and Kim Fleischer Michaelsen

45. Amino acid intake during lactation and amino acids of plasma and human milk ............................................................... 415
Isneida Ramirez, Soledad DeSantiago, Armando R Tovar, and Nimbe Torres
46. Negative balance of calcium during lactation in marginally nourished women ........................................ 423
   Leticia Alonso, Soledad DeSantiago, Ali Halhali, and Fernanda Perea

47. Do healthy very-low-birth-weight infants fed on their own mothers’ milk require sodium supplementation? ........................................ 431
   RN Musoke, RK Ayisi, DAO Orinda, and MJN Mbiti

SECTION VII. FUTURE PERSPECTIVES IN HUMAN MILK RESEARCH

Overview: The future of research in human milk ......................... 441
   Richard J Schanler

48. From bioactive substances to research on breast-feeding promotion .... 447
   Ardythe L Morrow and M Lourdes Guerrero

49. Protective role of human lactoferrin against invasion of
   *Shigella Flexneri* M90T ............................................... 457
   Henry F Gomez, Irene Herrera-Insua, Mustafa M Siddiqui,
   Vicente A Diaz-Gonzalez, Enrique Caceres, David S Newburg,
   and Thomas G Cleary

50. Binding of transcobalamin II by human mammary epithelial cells .... 469
   Yuriko Adkins and Bo Lönnnerdal

51. Diet, growth, and bone mineralization in premature infants ........... 479
   Jan Faerk, Sten Petersen, Birgit Peitersen,
   and Kim Fleischer Michaelsen

52. Fat content and fatty acid composition of fresh, pasteurized, or sterilized human milk .................................................. 485
   Natasa Fidler, Thorsten U Sauerwald, Hans Demmelmair,
   and Berthold Koletzko

53. Lymphocyte subpopulations in breast-fed and formula-fed infants at six months of age .................................................. 497
   Joanna S Hawkes and Robert A Gibson

SECTION VIII. GENERAL TOPICS IN HUMAN MILK RESEARCH

Overview: Breast-feeding, xenobiotics, and milk .......................... 507
   David S Newburg
Contents

54. Trends in donor milk banking in the United States ................. 509
   Lois DW Arnold

55. Bacterial toxins and enteral feeding of premature infants at risk for necrotizing enterocolitis ........................................ 519
   Linda C Duffy, Maria A Zielezny, Vivien Carrion, Elizabeth Griffiths, Diane Dryja, Milo Hilty, James Cummings, and Frederick Morin

56. Epidemiology of breast-feeding in Italy ............................ 529
   M Giovannini, G Banderali, C Agostoni, and E Riva

57. Analysis of casein using two-dimensional electrophoresis, western blot, and computer imaging ..................................... 535
   Marcia F Goldfarb

58. Consumption of lipophilic contaminants in human milk by infants: Quantities are usually incorrect ............................. 541
   Robert G Jensen, Carol J Lammi-Keefe, and Berthold Koletzko

59. Active transport of nitrofurantoin into rat milk .................... 547
   Cheah Y Oo, Earl W Paxton, and Patrick J McNamara

60. Influence of lysine on cimetidine uptake and on excretion of cimetidine by the rat mammary gland ............................... 553
   Phillip M Gerk, Earl W Paxton, Abhik M Bandyopadhyay, and Patrick J McNamara

61. The effect of pasteurization on transforming growth factor alpha and transforming growth factor beta 2 concentrations in human milk ..................................................... 559
   Rebecca J McPherson and Carol L Wagner

62. Can women remember when their milk came in? .................... 567
   Rafael Pérez-Escamilla and Donna Chapman

63. Glycosidase activities and sugar release in human milk .......... 573
   Gherman Ya Wiederschain and David S Newburg

Glossary ............................................................................. 579

Author Index .................................................................... 585

Subject Index .................................................................... 587