
The Ageing Immune System and Health

Valquiria Bueno • Janet M. Lord
Thomas A. Jackson
Editors

The Ageing Immune System and Health

 Springer

Editors

Valquiria Bueno
Department of Microbiology,
Immunology and Parasitology
UNIFESP Federal University of São Paulo
São Paulo, São Paulo, Brazil

Thomas A. Jackson
Institute of Inflammation and Ageing
University of Birmingham
University of Birmingham Research
Laboratories
Birmingham, UK

Queen Elizabeth Hospital
University Hospitals Birmingham
Foundation NHS Trust
Edgbaston, Birmingham UK

Janet M. Lord
MRC-ARUK Centre for Musculoskeletal
Ageing Research
Institute of Inflammation and Ageing
Birmingham University Medical School
Birmingham
Birmingham, UK

ISBN 978-3-319-43363-9

ISBN 978-3-319-43365-3 (eBook)

DOI 10.1007/978-3-319-43365-3

Library of Congress Control Number: 2016951977

© Springer International Publishing Switzerland 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The world population is undergoing a major demographic shift. As birth rates decline and people live longer due to advances in public health and medical science, the proportion of people over 65 is increasing. Moreover, people over 85 are the fastest growing section of society and often referred to as the “oldest old”. However, while life expectancy is rising at a rate of approximately 2 years per decade, this is not accompanied with a similar increase in disability-free life expectancy. So people are living longer, but in poorer health. However, as we age, we observe a greater heterogeneity of ability and health. The variation in, say, walking speed is far greater in a group of 70 year olds, than in a group on 20 year olds. This makes the study of ageing and the factors driving that heterogeneity of health and functional ability in old age vital.

Infectious disease in older people is associated with greater morbidity and mortality, so it is plausible that age-related changes to the immune system are central to this. The influenza virus is associated with greater hospitalisation and mortality in older people, and older people are more susceptible to complications of infection such as delirium. The study of the immune system across the lifespan has demonstrated that as we age the immune system undergoes a decline in function, termed immunosenescence. However, as discussed in Chaps. 1 and 2 the decline in function is not universal across all aspects of the immune system, and neither is the magnitude of functional loss similar between individuals. The theory of inflammageing, which represents a chronic low grade inflammatory state in older people, has been described as a major consequence of immunosenescence, though lifestyle factors such as reduced physical activity and increased adiposity also play a major role. Importantly, inflammageing may well explain the greater burden of disease in older people as increased systemic inflammation has been associated with greater risk of most of the age-related conditions including cardiovascular disease, cancer, sarcopaenia and dementia.

In poor health, older people accumulate disease, described as multimorbidity. This in turn means traditional single system based health care becomes less valid as each system affected by disease impacts on other systems. This leads some older people to be at greater risk of adverse events such as disability and death. The syndrome of this increased vulnerability is described as frailty, and increasing fundamental evidence is emerging that suggests immunosenescence and inflammageing

may underpin frailty and this is discussed in Chap. 9. Thus frailty is seen as one clinical manifestation of immunosenescence.

The understanding of how the immune system changes with age and can potentially be manipulated will impact on our current knowledge of older people living healthy lives and also can direct actions on how to improve the care of older people in ill health. The major aim is to improve disability-free life expectancy, so thereby adding life to years. The role that increasing physical activity may play in reducing immunosenescence and ill health in old age is covered in Chap. 10.

Despite the importance of the ageing immune system on both good and poor health in older people, there is a dearth of textbooks bringing together all aspects of the topic. In this book we aim to present up-to-date reviews on the key topics in the understanding of Ageing, Immune System, and Health. It is aimed at fundamental scientists and clinicians with an interest in ageing or the immune system. Each chapter aims to highlight current knowledge and also highlight knowledge gaps to stimulate further research.

Chapters include state-of-the-art reviews on immunosenescence in both the innate and adaptive immune systems. Others follow ageing and immunity in specific systems; lung senescence and epigenetics, as well as specific disease processes; cancer and cytomegalovirus infection. Vaccination is discussed in relation to older people, and the clinical and fundamental aspects of frailty are discussed.

Our goal is that improved recognition of the role played by a compromised immune system in ill health in old age, combined with the understanding that this can to a large extent be attenuated by lifestyle choices, will result in public health policy that ensures old age is enjoyed and not endured!

São Paulo, Brazil
Birmingham, UK
Birmingham, UK

Valquiria Bueno
Thomas A. Jackson
Janet M. Lord

Acknowledgments

The book *The Ageing Immune System and Health* is part of a UK-Brazil collaborative project with financial support to Prof. Bueno and Prof. Lord from FAPESP – São Paulo Research Foundation (2014/50261-8). We also acknowledge the support of the MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research to Prof. Lord.

Contents

1 Innate Immunosenescence and Its Impact on Health in Old Age	1
Mohammad Ahsan Tariq, Jon Hazeldine, and Janet M. Lord	
2 Effects of Ageing on Adaptive Immune Responses	21
Sian M. Henson	
3 The DNA Methylome: An Interface Between the Environment, Immunity, and Ageing	35
Lisa M. McEwen, Sarah J. Goodman, Michael S. Kobor, and Meaghan J. Jones	
4 The Role of CMV in Immunosenescence	53
Ludmila Müller, Klaus Hamprecht, and Graham Pawelec	
5 Effects of Ageing on the Vaccination Response	69
Birgit Weinberger	
6 Immunosenescence and the Ageing Lung	87
Krisztian Kvell and Judit E. Pongracz	
7 Cancer, Ageing and Immunosenescence	105
Nora Manoukian Forones and Valquiria Bueno	
8 Immune to Brain Communication in Health, Age and Disease: Implications for Understanding Age-Related Neurodegeneration	125
Jessica L. Teeling and Ayodeji A. Asuni	
9 Frailty and Ageing	141
Thomas A. Jackson, Daisy Wilson, and Carolyn A. Greig	
10 Lifestyle Interventions to Improve Immunosenescence	161
David B. Bartlett and Kim M. Huffman	
Index	177

Contributors

Ayodeji A. Asuni Department Neurodegeneration in vivo, Valby, Denmark

David B. Bartlett Duke Molecular Physiology Unit, Duke School of Medicine, Duke University, Durham, NC, USA

Duke Molecular Physiology Institute, Department of Medicine, Duke University Medical Center, Durham, NC, USA

Valquiria Bueno Department of Microbiology, Immunology and Parasitology, UNIFESP Federal University of São Paulo, São Paulo, Brazil

Nora Manoukian Forones Department of Medicine, UNIFESP Federal University of São Paulo, São Paulo, Brazil

Sarah J. Goodman Center for Molecular Medicine and Therapeutics, University of British Columbia, BC Children's Hospital, Vancouver, BC, Canada

Carolyn A. Greig MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research, University of Birmingham, Edgbaston, Birmingham, UK

School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Edgbaston, Birmingham, UK

Klaus Hamprecht Institute of Medical Virology, University of Tübingen, Tübingen, Germany

Jon Hazeldine MRC-ARUK Centre for Musculoskeletal Ageing Research, Institute of Inflammation and Ageing, Birmingham University Medical School, Birmingham, UK

Sian M. Henson Centre for Microvascular Research, William Harvey Research Institute, Barts and The London School of Medicine and Dentistry, Queen Mary, University of London, London, UK

Kim M. Huffman Duke Molecular Physiology Unit, Duke School of Medicine, Duke University, Durham, NC, USA

Thomas A. Jackson Institute of Inflammation and Ageing, University of Birmingham, University of Birmingham Research Laboratories, Queen Elizabeth Hospital, Birmingham, UK

Queen Elizabeth Hospital, University Hospitals Birmingham Foundation NHS Trust, Edgbaston, Birmingham, UK

Meaghan J. Jones Center for Molecular Medicine and Therapeutics, The University of British Columbia, BC Children's Hospital, Vancouver, BC, Canada

Michael S. Kobor Center for Molecular Medicine and Therapeutics, The University of British Columbia, BC Children's Hospital, Vancouver, BC, Canada

Krisztian Kvell Department of Pharmaceutical Biotechnology, School of Pharmacy, and Szentagothai Research Center, University of Pecs, Pecs, Hungary

Janet M. Lord MRC-ARUK Centre for Musculoskeletal Ageing Research, Institute of Inflammation and Ageing, Birmingham University Medical School, Birmingham, UK

Lisa M. McEwen Center for Molecular Medicine and Therapeutics, The University of British Columbia, BC Children's Hospital, Vancouver, BC, Canada

Ludmila Müller Max Planck Institute for Human Development, Berlin, Germany

Graham Pawelec Center for Medical Research, University of Tübingen, Tübingen, Germany

Division of Cancer Studies, Faculty of Life Sciences and Medicine, King's College London, London, UK

The John van Geest Cancer Research Centre, School of Science and Technology, Nottingham Trent University, Nottingham, UK

Judit E. Pongracz Department of Pharmaceutical Biotechnology, School of Pharmacy, and Szentagothai Research Center, University of Pecs, Pecs, Hungary

Mohammad Ahsan Tariq MRC-ARUK Centre for Musculoskeletal Ageing Research, Institute of Inflammation and Ageing, Birmingham University Medical School, Birmingham, UK

Jessica L. Teeling Centre for Biological Sciences, University of Southampton, Southampton, UK

Birgit Weinberger Research Institute for Biomedical Aging Research, University of Innsbruck, Innsbruck, Austria

Daisy Wilson Institute of Inflammation and Ageing, University of Birmingham, University of Birmingham Research Laboratories, Queen Elizabeth Hospital, Edgbaston, Birmingham, UK

MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research, University of Birmingham, Edgbaston, Birmingham, UK