The Sperm Cell

Second Edition

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Production, Maturation, Fertilization, Regeneration
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Edited by
Christopher J. De Jonge
University of Minnesota, Minneapolis, MN, USA
Christopher L. R. Barratt
University of Dundee, Ninewells Hospital, Dundee, UK

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Contributors

Mahmoud Aarabi, MD, PhD
Postdoctoral Fellow, Department of Human Genetics, School of Medicine, McGill University, Montreal, QC, Canada

Robert John Aitken, PhD
Pro Vice-Chancellor, Faculty of Health and Medicine, Laureate Professor of Biological Sciences, Priority Research Centre for Reproductive Science and President at the International Society of Andrology, The University of Newcastle, Callaghan, NSW, Australia

Ester Anton, PhD
Aggregate Professor at the Department of Cell Biology, Physiology and Immunology, Universitat Autònoma de Barcelona, Bellaterra (Cerdanyola del Vallès), Spain

Mark A. Baker, PhD
Head of Reproductive Proteomics, Discipline of Biological Sciences, University of Newcastle, Callaghan, NSW, Australia

Hanna Balakier, PhD
Laboratory Director, CReATe Fertility Centre, Toronto, ON, Canada

Christopher L. R. Barratt, PhD
Professor of Reproductive Medicine at the School of Medicine, University of Dundee, Ninewells Hospital, Dundee, UK

Katrine Bay, PhD
Scientific Writer, Department of Growth and Reproduction, Rigshospitalet, University of Copenhagen, Denmark, and International Center for Research and Research Training in Endocrine Disruption of Male Reproduction and Child Health (EDMaRC), Rigshospitalet, University of Copenhagen, Denmark

Clémence Belleannée, PhD
Associate Professor at the Department of Obstetrics, Gynecology and Reproduction, Université Laval, and Reproduction, Mother and Youth Health Division, CHU de Québec-Université Laval Research Center, QC, Canada

Peter R. Butler, BA
Center for Reproductive Medicine, Baylor College of Medicine, and the Scott Department of Urology, Baylor College of Medicine, Houston, TX, USA

Douglas T. Carrell, PhD
Department of Surgery (Urology) and Department of Human Genetics, University of Utah School of Medicine, Salt Lake City, UT, USA

Hector E. Chemes, MD, PhD
Laboratory of Testicular Physiology and Pathology, CEDIE-CONICET, Center for Research in Endocrinology, National Research Council, Endocrinology Division, Buenos Aires Children´s Hospital, Argentina

Stephanie Cheung, BS
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Tyler Cozzubbo, BS
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Christopher J. De Jonge, PhD
Director, Andrology Program at the University of Minnesota Medical Center, and Adjunct Professor at the Department of Urology, University of Minnesota, Minneapolis, MN, USA

Hanne Frederiksen, PhD
Senior Researcher at the Department of Growth and Reproduction, Rigshospitalet, University of Copenhagen, and International Center for Research and Research Training in Endocrine Disruption of Male Reproduction and Child Health (EDMaRC), Rigshospitalet, University of Copenhagen, Denmark

Zamira Gibb, PhD
Priority Research Centre for Reproductive Science and Discipline of Biological Sciences, The University of Newcastle, Callaghan, NSW, Australia

Ellen Goossens, PhD
Biology of the Testis Research Unit, Vrije Universiteit Brussel, Brussels, Belgium

Amin S. Herati, MD, PhD
Center for Reproductive Medicine, Baylor College of Medicine, and the Scott Department of Urology, Baylor College of Medicine, Houston, TX, USA

Timothy G. Jenkins, PhD
Department of Surgery (Urology), University of Utah School of Medicine, Salt Lake City, UT, USA

Tina Kold Jensen, MD, PhD
Consultant at the Department of Growth and Reproduction, Rigshospitalet, University of Copenhagen, Denmark, and Department of Environmental Medicine, Institute of Public Health, University of Southern Denmark, Odense, Denmark

Meritxell Jodar, PhD
Postdoctoral Fellow, Molecular Biology of Reproduction and Development Research Group, Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), University of Barcelona, Barcelona, Spain

Stephen A. Krawetz, PhD
Associate Director at the C.S. Mott Center for Human Growth and Development and Charlotte B. Failing Professor of Foetal Therapy and Diagnosis, Department of Obstetrics and Gynecology, Center for Molecular Medicine and Genetics, C.S. Mott Center for Human Growth and Development, Wayne State University School of Medicine, Detroit, MI, USA

F. Anthony Lai, PhD
Professor, College of Biomedical and Life Sciences, Cardiff University, Cardiff, UK

Dolores J. Lamb, PhD
Center for Reproductive Medicine, Baylor College of Medicine, the Scott Department of Urology, Baylor College of Medicine, and the Department of Molecular and Cellular Biology, Baylor College of Medicine, Houston, TX, USA

Jiude Mao, PhD
Research Assistant Professor, Division of Animal Sciences, University of Missouri, Columbia, MO, USA,

Queenie V. Neri, MSc
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Michail Nomikos, PhD
College of Biomedical and Life Sciences, Cardiff University, Cardiff, UK

Laura O'Hara, PhD
Postdoctoral Research Fellow at the MRC Centre for Reproductive Health, University of Edinburgh, The Queen's Medical Research Institute, Edinburgh, UK

Richard Oko, PhD
Professor, Department of Biomedical and Molecular Sciences, School of Medicine, Queen's University, Kingston, ON, Canada

Gianpiero D. Palermo, MD, PhD
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Nigel Pereira, MD
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Stephen Publicover, PhD
Reader in Reproductive Physiology, School of Biosciences, University of Birmingham, Edgbaston, Birmingham, UK

Zev Rosenwaks, MD
Ronald O. Perelman and Claudia Cohen Center for Reproductive Medicine, Weill Cornell Medical College, New York, NY, USA

Richard M. Sharpe, PhD
Honorary Professor at the MRC Centre for Reproductive Health, The Queen's Medical Research Institute, The University of Edinburgh, Edinburgh, UK

Niels E. Skakkebaek, MD
Senior Researcher at the Department of Growth and Reproduction, Rigshospitalet, University of Copenhagen, Denmark, and International Center for Research and Research Training in Endocrine Disruption of Male Reproduction and Child Health (EDMaRC), Rigshospitalet, University of Copenhagen, Denmark

Lee B. Smith, PhD
Professor, Chair of Genetic Endocrinology and Head of Male Health Research, MRC Centre for Reproductive Health, University of Edinburgh, The Queen's Medical Research Institute, Edinburgh, UK

Susan S. Suarez, PhD
Department of Biomedical Sciences, Cornell University College of Veterinary Medicine, Ithaca, NY, USA

Robert Sullivan, PhD
Professor at the Department of Obstetrics, Gynecology and Reproduction, Université Laval, and Reproduction, Mother and Youth Health Division, Centre de recherche du CHU de Québec-Université Laval, QC, Canada

Peter Sutovsky, PhD
Professor, Division of Animal Sciences, and Departments of Obstetrics, Gynecology & Women's Health, School of Medicine, University of Missouri, Columbia, MO, USA

Karl Swann
College of Biomedical and Life Sciences, Cardiff University, Cardiff, UK

Herman Tournaye, MD, PhD
Centre of Reproductive Medicine, University Hospital UZ Brussel, Brussels, Belgium

W. Steven Ward, PhD
Professor and Director at the Department of Anatomy, Biochemistry and Physiology, Institute for Biogenesis Research, and Chief, Research Division and Lakshmi Devi and Devraj Sharma Endowed Chair, Department of Obstetrics and Gynecology and Women's Health, John A. Burns School of Medicine, University of Hawaii at Manoa, Honolulu, HI, USA

Mariana F. Wolfner, PhD
Department of Molecular Biology and Genetics, Cornell University, Ithaca, NY, USA

Foreword

Eggs are made for sperm. Sperm are made for eggs. All other (body) cells are made to support, directly or indirectly, the development of eggs and sperm and the survival of their united product: the zygote – the next generation. The prime function of spermatozoa is to deliver the male genome safely into eggs. Any errors during sperm formation, maturation and union with eggs will result in serious problems in the male's fertility and in the wellbeing of the offspring.

This book covers our current knowledge of (1) the formation of spermatozoa, (2) the preparation of spermatozoa for fertilization, (3) the union of spermatozoa with eggs, (4) the awakening of 'sleeping' eggs by spermatozoa leading to embryo development, (5) genomic and nongenomic (e.g. environmental) factors affecting the development and fertility of spermatozoa, and (6) the challenges of overcoming male (sperm) fertility problems. Information compiled in each chapter should be considered a stepping stone to better understanding and better control of male fertility and infertility.

The very first chapter of this book mentions the possible production of 'artificial human spermatozoa' from pluripotent stem cells such as human iPSCs. Obviously, it is not appropriate to use live animals or get assistance from live animal cells to achieve this goal. To eliminate or minimize the stress and risks these cells would face during their transformation into haploid cells, we must learn much more about what is really happening in the natural environment of spermatogenic cells, within the testes. The last chapter considers the value of the mouse as a model for the study of mammalian fertility and infertility. Is the mouse a perfect animal model to use for the study of fertility and infertility of all mammals, including humans? Although the mouse is certainly one of the most heavily used model animals for studying mammalian fertility and reproduction, we must remember that each animal uses species-specific tactics to produce its offspring. What is found in one species must be extrapolated to other species with caution.

Today, it is theoretically possible to reproduce any mammals without males. In fact, hundreds of cows have already been produced by somatic cell nuclear transfer. Clearly, males are not essential for animal and human reproduction. Why are there males? At the beginning of life on Earth, there were no males. Females reproduced by themselves. During the course of evolution, a bisexual mode of reproduction emerged, and it has been maintained in most animals, including humans. Compared with animals propagating unisexually (females only), animals using a bisexual mode of reproduction seem to be less vulnerable to extinction in the face of constantly changing, competitive environments. Technically, human cloning (nonsexual reproduction) is possible today. In other words, humans can reproduce without males. Is this what we desire? A few years after the birth of Dolly (a cloned sheep) and many cloned mice, I gave talks to groups of people about animal and human cloning. At the end of my talk I asked the audience if they wanted to live in a world without men. With no exception, women did not want to live in the world without men. 'It would be boring. We cannot use men? That would be horrible.' Men are needed by women, and we will stay that way.

When I started research as an undergraduate student, I thought everything written in books and research papers was a fact. I now know that what is written is authors' interpretations or just a part of the whole story. Many things written in books and reported in original papers will be modified and even discarded during the next 40–50 years. Science progresses that way.

The comprehensive collection of topics that compose this new edition of *The Sperm Cell* provide readers with a map and compass to chart a course for future investigations. It is the readers' task after reading these highly topical research areas to determine what

subjects are left unclear and compelling, what next courses might be important to follow and what burgeoning questions are yet to be studied.

Ryuzo Yanagimachi, PhD
Professor Emeritus, Department of Anatomy, Biochemistry and Physiology, Institute of Biogenesis Research, John A. Burns School of Medicine, University of Hawaii, Honolulu, Hawaii

Preface

Ten years have quickly passed since the publication of *The Sperm Cell – Production, Maturation, Fertilization, Regeneration*. When published in 2006, this unique book provided a comprehensive introduction to the formation, generation and function of the human male gamete. Over the past 10 years science and technology have advanced remarkably and so similarly has advancement in understanding and characterizing the sperm cell. Thus, it is now very timely that we present a completely revised and much expanded second edition of *The Sperm Cell*.

In *The Sperm Cell*, second edition, we have again focused on providing the reader with a tapestry of topics that reveal a more comprehensive characterization into the generation and function of the spermatozoon and that encompasses both basic and clinical aspects. Up-to-date information on subjects where there has been very recent and rapid progress in our understanding – sperm cell epigenetics, proteomics and basic genetics and the consequences of such as potential markers of sperm function – is included. New topics have been added where novel data have revealed fascinating insights into the biology of reproduction, such as the role that seminal plasma may play in modifying both the female tract and the fertilising potential of sperm. Additionally, the book provides two chapters that present competing mechanisms for the process in which a sperm activates an egg. Importantly, a chapter on sperm ultrastructure is included. The application of electron microscopy for scrutinizing ultrastructural components provides amazing insights into the structure and function of the cell that are having an impact on clinical diagnoses.

There has been breathtaking progress in our knowledge base of the human spermatozoon, yet there is still much to learn, and many areas remain relatively poorly explored. For example, ICSI is still regarded as the primary treatment option for men with presumed sperm dysfunction. Insights provided in these chapters will hopefully stimulate investigations that will make less uncertain the structural and functional potential of sperm for fertilization and embryogenesis.

The remarkable cover art for *The Sperm Cell*, bears some similarity to the cover art of the first edition. However, a difference between the images can clearly be seen. For the latter, a somewhat foggy, less distinct cross-sectional image of the seminiferous tubule was used – reflecting, in essence, the 'scratching at the surface' knowledge base of the field at the time. The present cover shows an image of a seminiferous tubule that is sharp and distinct, reflecting greater clarity – clarity in our understanding and characterization of this most unique cell, the spermatozoon.

Our hope is that the collective contributions in this book will inspire and encourage the next generation of research and clinical scientists to the field and, perhaps, reinvigorate older and experienced scientists to think anew from the fresh perspectives offered in *The Sperm Cell*, second edition.

Christopher J. De Jonge
Christopher L. R. Barratt