Fertilization

The Beginning of Life

Fertilization

The Beginning of Life

Brian Dale
Centre for Assisted Fertilization, Naples

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781316607893
DOI: 10.1017/9781316650318

First published 2018

Printed in the United Kingdom by TJ International Ltd. Padstow Cornwall

A catalogue record for this publication is available from the British Library.

Library of Congress Cataloging-in-Publication Data
Names: Dale, Brian, author.
Title: Fertilization : the beginning of life / Brian Dale.
Description: Cambridge, United Kingdom ; New York, NY : Cambridge University Press, 2018. | Includes bibliographical references.
Identifiers: LCCN 2018010116 | ISBN 9781316607893 (paperback)
Subjects: LCSH: Fertilization (Biology) | Germ cells. | Gametogenesis. | MESH: Fertilization – physiology | Germ Cells – physiology | Gametogenesis – physiology | Embryonic Development
Classification: LCC QH485 .D35 2018 | NLM QH 485 | DDC 571.8/64–dc23
LC record available at https://lccn.loc.gov/2018010116

ISBN 978-1-316-60789-3 Paperback

This book is dedicated to Loredana, Daniela, Peter, Roberta and Rebecca.

Contents

Preface

Despite its importance in human-assisted reproduction, agriculture and fisheries, not to mention our very existence, the subject of fertilization receives little attention in textbooks of reproductive or developmental biology. The aim of this book is to introduce the reader to this fascinating process where two highly specialized cells interact to form a new life. Using examples from the echinoderms, ascidians, amphibians, fish, mammals and other phyla, I will try to show that, despite the variability in form of metazoan gametes, the mechanism of fertilization is highly conserved throughout the animal kingdom. Since there are over 3,000 specialized papers published annually on this subject, I can only outline the basic principles involved in fertilization and invite readers who require more details to refer to more specialized texts. Fertilization is about the transformation of a quiescent oocyte, which is primarily concerned with attracting its partner gamete, into a dynamic zygote that undergoes a cascade of predetermined activation events to set the scene for the early embryo. Many events are about reorganizing components laid down in the oocyte during oogenesis; therefore, I have summarized the principles of producing gametes in Chapter 2. In some animals this maternal information is polarized in the oocyte, and partitioning at cleavage gives rise to different cell lineages in the early embryo, whereas in others, early blastomeres remain totipotent. These differences are covered in Chapter 7. The main theme of this book is to decipher the spatial and temporal complexity of fertilization under natural conditions and, in particular, to show how each gamete induces successive physiological changes in its partner that are essential for the formation of the zygote. Fertilization studies are fraught with contrasting ideas, often arising from artefacts induced by in vitro studies, where techniques to prepare gametes have distorted the results of experiments. For example, techniques that bypass essential stages of the fertilization process, such as removing extracellular coats or avoiding gamete fusion by micro-injecting sperm into oocytes, not only change the physiology of the cells but also give the impression that these structures or processes are not required for fertilization. Chapter 6 (modified from *The Encyclopedia of Reproduction*, second edition, Elsevier) looks at the dynamics of sperm–oocyte interaction, taking care to reflect the situation under natural conditions and avoiding misleading interpretations from laboratory experiments. To improve the flow of the book, basic biological processes common to all cells, such as cell division, electrical properties and metabolism are treated in a separate chapter at the end of the book.

I have had the honour to work with some outstanding scientists – Alberto Monroy, Giuseppina Ortolani, Berndt Hagstrom, Louis DeFelice, Yves Menezo and Jacques Cohen, to mention a few – and the privilege to work in a period of unparalleled enthusiasm, where scientists such as Alberto Monroy, Daniel Mazia, Jean Brachet, Eric Davidson, Mike Bedford, Robert Edwards and Ryuzo Yanagimachi set the pace in studies of fertilization. I wish to thank the Stazione Zoologica in Naples, the first and most unique marine biology laboratory in the world, for allowing me the opportunity to work there from 1976 until 1999 on a variety of invertebrate and vertebrate species, and the late Alberto Monroy for introducing me to this fascinating subject.