

Get Full Access and More at

ExpertConsult.com

Yen & Jaffe's
**REPRODUCTIVE
ENDOCRINOLOGY**

PHYSIOLOGY, PATHOPHYSIOLOGY, AND
CLINICAL MANAGEMENT

SEVENTH EDITION

STRAUSS ■ BARBIERI

Yen & Jaffe's Reproductive Endocrinology

Physiology, Pathophysiology, and Clinical Management

SEVENTH EDITION

Jerome F. Strauss III, MD, PhD

Executive Vice President for Medical Affairs
VCU Health System;
Dean, School of Medicine
Virginia Commonwealth University
Richmond, Virginia

Robert L. Barbieri, MD

Kate Macy Ladd Professor
Department of Obstetrics, Gynecology,
and Reproductive Biology
Harvard Medical School;
Chair, Department of Obstetrics and Gynecology
Brigham and Women's Hospital
Boston, Massachusetts

ELSEVIER
SAUNDERS

ELSEVIER
SAUNDERS

1600 John F. Kennedy Blvd.
Ste 1800
Philadelphia, PA 19103-2899

YEN & JAFFE'S REPRODUCTIVE ENDOCRINOLOGY: PHYSIOLOGY, PATHOPHYSIOLOGY,
AND CLINICAL MANAGEMENT, SEVENTH EDITION ISBN: 978-1-4557-2758-2

Copyright © 2014 by Saunders, an imprint of Elsevier Inc.

Copyright © 2009, 2004, 1999, 1991, 1986, 1978 by Saunders, an imprint of Elsevier Inc.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the Publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

With respect to any drug or pharmaceutical products identified, readers are advised to check the most current information provided (i) on procedures featured or (ii) by the manufacturer of each product to be administered, to verify the recommended dose or formula, the method and duration of administration, and contraindications. It is the responsibility of practitioners, relying on their own experience and knowledge of their patients, to make diagnoses, to determine dosages and the best treatment for each individual patient, and to take all appropriate safety precautions.

To the fullest extent of the law, neither the Publisher nor the Authors, Contributors, or Editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Library of Congress Cataloging-in-Publication Data

Yen and Jaffe's reproductive endocrinology: physiology, pathophysiology, and clinical management / [edited by] Jerome F. Strauss III, Robert Barbieri. -- 7th ed.

p. ; cm.

Reproductive endocrinology

Includes bibliographical references and index.

ISBN 978-1-4557-2758-2 (hardcover)

I. Strauss, Jerome F. (Jerome Frank), 1947- II. Barbieri, Robert L. III. Yen, Samuel S. C., 1927-2006.

Reproductive endocrinology. IV. Title: Reproductive endocrinology.

[DNLM: 1. Reproduction--physiology. 2. Endocrine Glands--physiology. 3. Endocrine System Diseases--physiopathology. WQ 205]

QP252

612.6--dc23

2013010137

Acquisitions Editor: Stefanie Jewell-Thomas

Developmental Editor: Kel McGowan

Publishing Services Manager: Jeff Patterson

Project Manager: Bill Drone

Design Direction: Steve Stave

Printed in China

Last digit is the print number: 9 8 7 6 5 4 3 2 1



Working together
to grow libraries in
developing countries

www.elsevier.com • www.bookaid.org

Yen & Jaffe's Reproductive Endocrinology

Remembrance

Samuel S. C. Yen, MD, DSc

1927–2006

In 2006, endocrinology in general, and reproductive endocrinology in particular, lost a giant in clinical and translational reproductive endocrinologic research, Samuel S. C. Yen. He was insightful and a visionary and demanded excellence from his trainees, but no more so than from himself. He was arguably the leading clinical reproductive neuroendocrinologist of his time.

He and I coedited the first four editions of this textbook, which has since been translated from English into five languages—including a pirated version from China. The genesis of our textbook was crystallized during our time at the magnificent, idyllic Rockefeller Foundation retreat, the Villa Serbelloni, at the nexus of the three legs of Lake Como in Italy. It was there, surrounded by scholars from a panoply of disciplines and countries (Sam and I were the only physicians in the group), that we had the time and freedom to finalize the chapters. We mutually selected the authors, most of whom were outstanding investigators and clinicians in the areas about which they wrote (albeit not all as expeditiously as we had hoped).

Fortunately, our first editor, John Hanley, was a true scholar who shared our passion for quality and excellence. Our original publisher, W. B. Saunders, shared that same passion.

Sam continued his insistence on excellence for each edition, and he cajoled several of our authors until they did the same.

Sam's chapters on neuroendocrine regulation of the brain and of the hypothalamic-pituitary-ovarian axis are classic. His extensive and productive collaboration with his very close friend, the Nobel Laureate Roger Guillemin, who characterized many of the hypothalamic secretagogues that Sam used in his clinical studies, enabled him to base many of his comments in the textbook on his own laboratory's studies.

Sam was hard-driving, yet charming, as demanding of himself and our authors as he was of the myriad investigators with whom he worked and trained. His was a rich, full, productive, and creative life. He was a unique and colorful individual.

His like comes along very rarely.

Robert B. Jaffe, MD
University of California,
San Francisco
2008

Contributors

VALERIE A. ARBOLEDA, PhD

Department of Human Genetics
David Geffen School of Medicine at UCLA
Los Angeles, California

Chapter 17: Disorders of Sex Development

MARIO ASCOLI, PhD

Professor
Departments of Pharmacology and Obstetrics and
Gynecology
The University of Iowa
Carver College of Medicine
Iowa City, Iowa

Chapter 2: The Gonadotropin Hormones and Their Receptors

RICHARD J. AUCHUS, MD, PhD

Professor and Endocrinology Fellowship Program Director
Department of Internal Medicine
Division of Metabolism, Endocrinology, and Diabetes
University of Michigan
Ann Arbor, Michigan

Chapter 25: Endocrine Disturbances Affecting Reproduction

ROBERT L. BARBIERI, MD

Kate Macy Ladd Professor
Department of Obstetrics, Gynecology, and Reproductive
Biology
Harvard Medical School;
Chair, Department of Obstetrics and Gynecology
Brigham and Women's Hospital
Boston, Massachusetts

Chapter 11: The Breast

Chapter 23: Female Infertility

KURT BARNHART, MD, MSCE

The William Shippen, Jr., Professor of Obstetrics and
Gynecology
Director, Women's Health Clinical Research Center;
Assistant Dean for Clinical Research Operations
Department of Obstetrics and Gynecology and
Epidemiology
Perelman School of Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

Chapter 36: Contraception

CHARLES L. BORMANN, PhD

Instructor of Obstetrics, Gynecology, and Reproductive
Biology
Harvard Medical School;
Associate Director, ART Laboratory
Department of Obstetrics and Gynecology
Brigham & Women's Hospital
Boston, Massachusetts

Chapter 32: Gamete and Embryo Manipulation

ROBERT E. BRANNIGAN, MD

Associate Professor
Department of Urology
Director, Andrology Fellowship
Northwestern University
Feinberg School of Medicine
Chicago, Illinois

Chapter 33: Fertility Preservation

JOHN M. BUSILLO, PhD

IRTA Fellow
Molecular Endocrinology
National Institute of Environmental Health Sciences,
National Institutes of Health
Research Triangle Park, North Carolina

Chapter 5: Steroid Hormone Action

ENRICO CARMINA, MD

Professor
Endocrino-Metabolic and Cardiovascular Unit
DISMOT Department
University of Palermo
Palermo, Italy

Chapter 34: Laboratory Assessment

ALICE Y. CHANG, MD, MSC

Assistant Professor
Division of Endocrinology, Diabetes, Metabolism, and
Nutrition
Department of Internal Medicine
Mayo Clinic
Rochester, Minnesota

Chapter 25: Endocrine Disturbances Affecting Reproduction

R. JEFFREY CHANG, MD

Professor
Department of Reproductive Medicine
University of California, San Diego
La Jolla, California

Chapter 22: Polycystic Ovary Syndrome and Hyperandrogenic States**CHARLES CHAPRON, MD**

Professor and Chair
Department of Obstetrics and Gynecology II and Reproductive Medicine
Université Paris Descartes, Sorbonne Paris Cité;
CHU Cochin
Paris, France

Chapter 35: Pelvic Imaging in Reproductive Endocrinology**JOHN A. CIDLOWSKI, PhD**

Principal Investigator and Chief
Laboratory of Signal Transduction
Department of Health and Human Services
National Institute of Environmental Health Sciences,
National Institutes of Health
Research Triangle Park, North Carolina

Chapter 5: Steroid Hormone Action**CATERINA CLEMENTI, MS**

Graduate Student
Department of Pathology and Immunology
Program in Developmental Biology
Baylor College of Medicine
Houston, Texas

Chapter 7: Growth Factors and Reproduction**STEPHEN H. CULP, MD, PhD**

Assistant Professor
Department of Urology
University of Virginia
Charlottesville, Virginia

Chapter 29: Hormone Responsive Cancers**DOMINIQUE DE ZIEGLER, MD**

Professor and Head
Division of Reproduction, Endocrinology, and Infertility
Department of Obstetrics and Gynecology
Université Descartes - Hôpital Cochin, AHP – Cochin
Hospital
Paris, France

Chapter 35: Pelvic Imaging in Reproductive Endocrinology**FRANCESCA E. DUNCAN, PhD**

Research Assistant Professor
Department of Obstetrics and Gynecology
Northwestern University
Feinberg School of Medicine
Chicago, Illinois

Chapter 33: Fertility Preservation**LINDA R. DUSKA, MD**

Associate Professor and Fellowship Director
Division of Gynecologic Oncology
University of Virginia Health System
Charlottesville, Virginia

Chapter 29: Hormone Responsive Cancers**ANDREA G. EDLOW, MD, MSC**

Maternal-Fetal Medicine Fellow
Department of Obstetrics and Gynecology
Tufts Medical Center
Boston, Massachusetts

Chapter 28: Endocrine Diseases of Pregnancy**WILLIAM S. EVANS, MD**

Professor
Departments of Medicine and Obstetrics and Gynecology
University of Virginia School of Medicine
Charlottesville, Virginia

Chapter 21: Physiological and Pathophysiological Alterations of the Neuroendocrine Components of the Reproductive Axis**BART C.J.M. FAUSER, MD, PhD**

Professor of Reproductive Medicine
University Utrecht;
Chair Division Woman and Baby
University Medical Center Utrecht
Utrecht, The Netherlands

Chapter 30: Medical Approaches to Ovarian Stimulation for Infertility**GARRET A. FITZGERALD, MD, FRCS**

Director, Institute for Translational Medicine & Therapeutics;
Chair, Department of Pharmacology
Perelman School of Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

Chapter 6: Prostaglandins and Other Lipid Mediators in Reproductive Medicine**COLIN D. FUNK, PhD**

Professor and Tier I Canada Research Chair
Department of Biomedical and Molecular Sciences
Queen's University
Ontario, Canada

Chapter 6: Prostaglandins and Other Lipid Mediators in Reproductive Medicine**ELIZABETH S. GINSBURG, MD**

Associate Professor of Obstetrics, Gynecology, and Reproductive Biology
Harvard Medical School;
Medical Director, Assisted Reproductive Technologies Program
Department of Obstetrics and Gynecology
Brigham & Women's Hospital
Boston, Massachusetts

Chapter 31: Assisted Reproduction

LINDA C. GIUDICE, MD, PhD

Distinguished Professor and Chair
 Department of Obstetrics, Gynecology, and Reproductive
 Sciences
 The Robert B. Jaffe, MD, Endowed Professor in the
 Reproductive Sciences
 University of California, San Francisco
 San Francisco, California

Chapter 20: Environmental Factors and Reproduction**JANET E. HALL, MD**

Professor of Medicine
 Harvard Medical School;
 Associate Chief, Reproductive Endocrine Unit
 Massachusetts General Hospital
 Boston, Massachusetts

Chapter 8: Neuroendocrine Control of the Menstrual Cycle**KRISTIN D. HELM, MD**

Endocrinology Division Director
 Harbor Medical Associates and South Shore Hospital
 South Weymouth, Massachusetts

Chapter 21: Physiological and Pathophysiological Alterations of the Neuroendocrine Components of the Reproductive Axis**ZARAA KHAN, MBBS**

Clinical Fellow
 Department of Reproductive Endocrinology and Infertility
 Mayo Clinic
 Rochester, Minnesota

Chapter 27: Benign Uterine Disorders**LAXMI A. KONDAPALLI, MD, MSCE**

Assistant Professor
 Department of Obstetrics and Gynecology
 University of Colorado Denver
 Aurora, Colorado

Chapter 19: Nutrition and Reproduction**WILLIAM HANNA KUTTEH, MD, PhD, HCLD**

Clinical Professor of Obstetrics and Gynecology
 Vanderbilt University Medical Center;
 Managing Partner, Fertility Associates of Memphis
 Memphis, Tennessee

Chapter 14: Immunology and Reproduction**DAN I. LEBOVIC, MD**

Professor
 Director, Division of Reproductive Endocrinology and
 Infertility
 Department of Obstetrics and Gynecology
 University of Wisconsin, Madison
 Madison, Wisconsin

Chapter 26: Endometriosis**BRUCE A. LESSEY, MD**

Division of Reproductive Endocrinology and Infertility
 Department of Obstetrics and Gynecology
 University of South Carolina School of Medicine-
 Greenville
 Greenville, South Carolina

Chapter 10: The Structure, Function, and Evaluation of the Female Reproductive Tract**PETER Y. LIU, MB, BS (HONS I), FRACP, PhD**

Principal Investigator
 Division of Endocrinology
 Los Angeles Biomedical Research Institute at Harbor-
 UCLA Medical Center

Torrance, California;
 Visiting Professor of Medicine
 David Geffen School of Medicine at UCLA
 Los Angeles, California

Chapter 13: The Hypothalamo-Pituitary Unit, Testis, and Male Accessory Organs**ROGERIO A. LOBO, MD**

Professor
 Department of Obstetrics and Gynecology
 Columbia University College of Physicians & Surgeons
 New York, New York

Chapter 15: Menopause and Aging**Chapter 34: Laboratory Assessment****JOHN C. MARSHALL, MD, PhD**

Andrew D. Hart Professor of Medicine
 Division of Endocrinology and Metabolism;
 Director, Center for Research in Reproduction
 University of Virginia Health System
 Charlottesville, Virginia

Chapter 1: Neuroendocrinology of Reproduction**MARTIN M. MATZUK, MD, PhD**

Stuart A. Wallace Chair and Professor
 Department of Pathology and Immunology
 Program in Developmental Biology
 Baylor College of Medicine
 Houston, Texas

Chapter 7: Growth Factors and Reproduction**CHRISTOPHER R. MCCARTNEY, MD**

Associate Professor of Medicine
 Division of Endocrinology and Metabolism
 Center for Research in Reproduction
 University of Virginia Health System
 Charlottesville, Virginia

Chapter 1: Neuroendocrinology of Reproduction**SAM MESIANO, PhD**

Associate Professor
 Department of Reproductive Biology
 Case Western Reserve University
 Cleveland, Ohio

Chapter 12: The Endocrinology of Human Pregnancy and Fetal-Placental Neuroendocrine Development

MARK E. MOLITCH, MD

Martha Leland Sherwin Professor of Endocrinology
Division of Endocrinology, Metabolism, and Molecular
Medicine
Northwestern University
Feinberg School of Medicine
Chicago, Illinois

Chapter 3: Prolactin in Human Reproduction**PREMA NARAYAN, PhD**

Associate Professor
Department of Physiology
School of Medicine
Southern Illinois University
Carbondale, Illinois

Chapter 2: The Gonadotropin Hormones and Their Receptors**RALF NASS, MD**

Assistant Professor
Department of Endocrinology and Metabolism
University of Virginia School of Medicine
Charlottesville, Virginia

Chapter 21: Physiological and Pathophysiological Alterations of the Neuroendocrine Components of the Reproductive Axis**ERROL R. NORWITZ, MD, PhD**

Louis E. Phaneuf Professor of Obstetrics and Gynecology
Tufts University School of Medicine;
Chair, Department of Obstetrics and Gynecology
Tufts Medical Center
Boston, Massachusetts

Chapter 28: Endocrine Diseases of Pregnancy**STEPHANIE A. PANGAS, PhD**

Assistant Professor
Departments of Pathology and Immunology and Molecular
and Cellular Biology
Baylor College of Medicine
Houston, Texas

Chapter 7: Growth Factors and Reproduction**TONY M. PLANT, PhD**

Professor
Departments of Obstetrics, Gynecology, and Reproductive
Sciences and Cell Biology and Physiology
University of Pittsburgh School of Medicine
Magee-Womens Research Institute
Pittsburgh, Pennsylvania

Chapter 18: Puberty: Gonadarche and Adrenarche**ALEX J. POLOTSKY, MD, MSC**

Associate Professor
Department of Obstetrics and Gynecology
University of Colorado Denver
Aurora, Colorado

Chapter 19: Nutrition and Reproduction**CATHERINE RACOWSKY, PhD**

Professor
ART Laboratory Director
Department of Obstetrics, Gynecology and Reproductive
Biology
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts

Chapter 31: Assisted Reproduction**TURK RHEN, PhD**

Associate Professor
Department of Biology
University of North Dakota
Grand Forks, North Dakota

Chapter 5: Steroid Hormone Action**JESSICA RIEDER, MD, MS**

Associate Clinical Professor of Pediatrics
Department of Pediatrics (Adolescent Medicine)
Albert Einstein College of Medicine
Yeshiva University
Bronx, New York

Chapter 19: Nutrition and Reproduction**RICHARD J. SANTEN, MD**

Professor of Medicine
Department of Internal Medicine
Division of Endocrinology and Metabolism
University of Virginia Health Sciences System
Charlottesville, Virginia

Chapter 29: Hormone Responsive Cancers**NANETTE SANTORO, MD**

Professor and Chair
Department of Obstetrics and Gynecology
University of Colorado Denver
Aurora, Colorado

Chapter 19: Nutrition and Reproduction**PIETRO SANTULLI, MD, MSC**

Doctor, Department of Obstetrics and Gynecology II and
Reproductive Medicine
Hôpital Cochin
Université Paris Descartes, Sorbonne Paris Cité;
Unité de recherche
Institut Cochin
Paris, France

Chapter 35: Pelvic Imaging in Reproductive Endocrinology**COURTNEY A. SCHREIBER, MD, MPH**

Assistant Professor
Department of Obstetrics and Gynecology;
Program Director, Fellowship in Family Planning
Perelman School of Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

Chapter 36: Contraception

DANNY J. SCHUST, MD

Associate Professor
 William T. Griffin, MD, Distinguished Faculty Scholar;
 Director, Division of Reproductive Medicine and Fertility
 Department of Obstetrics, Gynecology, and Women's
 Health
 University of Missouri School of Medicine
 Columbia, Missouri

Chapter 14: Immunology and Reproduction**PETER J. SNYDER, MD**

Professor of Medicine
 University of Pennsylvania
 Philadelphia, Pennsylvania

Chapter 16: Male Reproductive Aging**WEN-CHAO SONG, PhD**

Professor of Pharmacology
 Perelman School of Medicine
 University of Pennsylvania
 Philadelphia, Pennsylvania

Chapter 6: Prostaglandins and Other Lipid Mediators in Reproductive Medicine**FRANK Z. STANCZYK, PhD**

Professor of Research, Obstetrics, and Gynecology
 and Preventive Medicine
 University of Southern California
 Keck School of Medicine
 Los Angeles, California

Chapter 34: Laboratory Assessment**ELIZABETH A. STEWART, MD**

Professor of Obstetrics and Gynecology
 Chair, Division of Reproductive Endocrinology
 Mayo Clinic
 Mayo School of Medicine
 Rochester, Minnesota

Chapter 27: Benign Uterine Disorders**DALE W. STOVALL, MD**

Professor
 Department of Internal Medicine
 University of Virginia
 Charlottesville, Virginia;
 Chair and Residency Director
 Department of Obstetrics and Gynecology
 Riverside Regional Medical Center
 Newport News, Virginia

Chapter 14: Immunology and Reproduction**JEROME F. STRAUSS III, MD, PhD**

Executive Vice President for Medical Affairs
 VCU Health System;
 Dean, School of Medicine
 Virginia Commonwealth University
 Richmond, Virginia

Chapter 4: The Synthesis and Metabolism of Steroid Hormones**Chapter 9: The Ovarian Life Cycle****ISABELLE STREULI, MD, MSC**

Faculty
 Department of Gynecology, Obstetrics, and Reproductive
 Medicine
 Université Paris Descartes, Paris Sorbonne Cité
 Paris, France;
 Department of Gynecology and Obstetrics
 Unit for Reproductive Medicine and Gynecological
 Endocrinology
 Hôpitaux Universitaires de Genève
 Geneva, Switzerland

Chapter 35: Pelvic Imaging in Reproductive Endocrinology**PATRICE SUTTON, MPH**

Research Scientist
 Program on Reproductive Health and the Environment
 Department of Obstetrics, Gynecology, and Reproductive
 Sciences
 University of California, San Francisco
 San Francisco, California

Chapter 20: Environmental Factors and Reproduction**ROBERT TAYLOR, MD, PhD**

Professor and Vice Chair for Research
 Department of Obstetrics and Gynecology
 Wake Forest School of Medicine;
 Attending Reproductive Endocrinologist
 Department of Obstetrics and Gynecology
 Wake Forest Baptist Health;
 Member
 Molecular Medicine and Translational Sciences Graduate
 Program
 Wake Forest School of Medicine
 Winston-Salem, North Carolina

Chapter 26: Endometriosis**JESSICA TROWBRIDGE, MPH**

Research Scientist
 Program on Reproductive Health and the Environment
 University of California, San Francisco
 San Francisco, California

Chapter 20: Environmental Factors and Reproduction**PAUL J. TUREK, MD**

Director
 The Turek Clinic
 San Francisco, California

Chapter 24: Male Infertility**JOHANNES D. VELDHUIS, MD**

Professor
 Mayo Medical School;
 Consultant in Medicine
 Clinical Investigator
 Department of Medicine and Physiology
 Endocrine Research Unit and Biophysics Section
 Mayo School of Graduate Medical Education
 Mayo Clinic
 Rochester, Minnesota

Chapter 13: The Hypothalamo-Pituitary Unit, Testis, and Male Accessory Organs

ERIC VILAIN, MD, PhD

Professor
Department of Human Genetics, Pediatrics, and Urology;
Chief, Division of Medical Genetics
Department of Pediatrics
University of California, Los Angeles School of Medicine;
Director, Institute for Society and Genetics
University of California, Los Angeles
Los Angeles, California

Chapter 17: Disorders of Sex Development

CARMEN J. WILLIAMS, MD, PhD

Clinical Investigator, Laboratory of Reproductive &
Developmental Toxicology
National Institute of Environmental Health Sciences
Research Triangle Park, North Carolina

Chapter 9: The Ovarian Life Cycle

SELMA FELDMAN WITCHEL, MD

Associate Professor of Pediatrics
Director, Pediatric Endocrinology Fellowship Program
Division of Pediatric Endocrinology
Children's Hospital of Pittsburgh of UPMC
University of Pittsburgh
Pittsburgh, Pennsylvania

Chapter 18: Puberty: Gonadarche and Adrenarche

TERESA K. WOODRUFF, PhD

Thomas J. Watkins Professor of Obstetrics and Gynecology
Northwestern University
Feinberg School of Medicine
Chicago, Illinois

Chapter 33: Fertility Preservation

TRACEY J. WOODRUFF, PhD, MPH

Professor
Director, Program on Reproductive Health and the
Environment
Department of Obstetrics, Gynecology, and Reproductive
Sciences
University of California, San Francisco
San Francisco, California

Chapter 20: Environmental Factors and Reproduction

STEVEN L. YOUNG, MD, PhD

Associate Professor
Department of Obstetrics and Gynecology
Division of Reproductive Endocrinology
University of North Carolina School of Medicine
Chapel Hill, North Carolina

**Chapter 10: The Structure, Function, and Evaluation
of the Female Reproductive Tract**

Preface

A centerpiece of reproductive endocrinology is the utilization of assisted reproductive technologies, including *in vitro* fertilization (IVF), to build healthy families. In 1978, the first baby born from IVF, Louise Brown, was proof of the concept that successful human pregnancy was possible following *in vitro* fertilization. In the same year, the first edition of Yen and Jaffe was published and represented the birth of a field with a strong research foundation, whose findings had direct applicability to health. Three decades later, the 2010 Nobel Prize in Medicine or Physiology was awarded to Sir Robert G. Edwards, Ph.D. (b. 1925, d. 2013), for his seminal contributions to the field of reproductive endocrinology and infertility. The publication of the 7th edition of Yen and Jaffe is dedicated to Dr. Edwards and all the pioneers who have devoted their energies to advancing the field.

In the first years of the development of the field, a major focus was on the endocrine mechanisms that supported the optimal development of oocyte and sperm, their interaction and the implantation of an embryo in the developmentally prepared endometrium. Today, interest in germ cell development and germ cell biology has gained great prominence, raising the possibility of application of stem cell-based therapeutics to treat infertility and gene disorders. Fertility preservation through the cryopreservation of sperm and oocytes has emerged as a key element of care for the cancer patient and others who face concerns regarding retention of reproductive potential. The importance of these translational advances is recognized by the addition of new chapters to this edition.

The completion of the sequencing of the human genome and the reduction in cost in whole genome analysis have opened new opportunities for finding genes that affect different aspects of reproduction, such as genes that affect the

age of menarche and the age of menopause; genes that predispose to endometriosis, uterine fibroids, and polycystic ovary syndrome; and genes that influence ovarian reserve and spermatogenesis. These important discoveries, which will shed light on pathophysiology and new avenues for diagnosis and treatment, are highlighted in the present edition.

Since the publication of the last edition of this text, we have achieved a better understanding of environmental factors influencing fertility, including obesity. These contemporary issues have been addressed in this edition. Epigenetic factors are thought to mediate the impact of environmental exposures on gametes and embryos and the developing fetus. They are also believed to be responsible for intergenerational effects. Although still in its infancy, the science of epigenetics holds promise for explaining reproductive phenotypes and reproductive outcomes.

We appreciate the collaboration of past and new authors for their critical evaluation of the state of their respective fields. Their contributions have enriched this text and we are grateful for their efforts. They have helped carry forward the tradition of excellence that Drs. Jaffe and Yen created when they brought forward the first edition of this text.

Acknowledgments

The Editors thank William Drone, Kel McGowan, Stefanie Jewell-Thomas, and Steven Stave of Elsevier; and Karen Olinger and Deborah Weir of Virginia Commonwealth University, for their assistance in the preparation of this volume.

Jerome F. Strauss III, MD, PhD

Robert L. Barbieri, MD

**Yen & Jaffe's
Reproductive
Endocrinology**

Contents

PART 1

ENDOCRINOLOGY OF REPRODUCTION

- 1 Neuroendocrinology of Reproduction 3
Christopher R. McCartney
John C. Marshall
- 2 The Gonadotropin Hormones and Their Receptors 27
Mario Ascoli
Prema Narayan
- 3 Prolactin in Human Reproduction 45
Mark E. Molitch
- 4 The Synthesis and Metabolism of Steroid Hormones 66
Jerome F. Strauss III
- 5 Steroid Hormone Action 93
John M. Busillo
Turk Rhen
John A. Cidlowski
- 6 Prostaglandins and Other Lipid Mediators in Reproductive Medicine 108
Colin D. Funk
Wen-Chao Song
Garret A. FitzGerald
- 7 Growth Factors and Reproduction 124
Caterina Clementi
Stephanie A. Pangas
Martin M. Matzuk
- 8 Neuroendocrine Control of the Menstrual Cycle 141
Janet E. Hall
- 9 The Ovarian Life Cycle 157
Jerome F. Strauss III
Carmen J. Williams
- 10 The Structure, Function, and Evaluation of the Female Reproductive Tract 192
Bruce A. Lessey
Steven L. Young
- 11 The Breast 236
Robert L. Barbieri

- 12 The Endocrinology of Human Pregnancy and Fetal-Placental Neuroendocrine Development 243
Sam Mesiano
- 13 The Hypothalamo-Pituitary Unit, Testis, and Male Accessory Organs 272
Peter Y. Liu
Johannes D. Veldhuis
- 14 Immunology and Reproduction 287
William Hannah Kutteh
Dale W. Stovall
Danny J. Schust
- 15 Menopause and Aging 308
Rogerio A. Lobo
- 16 Male Reproductive Aging 340
Peter J. Snyder

PART 2

PATHOPHYSIOLOGY AND THERAPY

- 17 Disorders of Sex Development 351
Valerie A. Arboleda
Eric Vilain
- 18 Puberty: Gonadarche and Adrenarche 377
Selma Feldman Witchel
Tony M. Plant
- 19 Nutrition and Reproduction 422
Nanette Santoro
Alex J. Polotsky
Jessica Rieder
Laxmi A. Kondapalli
- 20 Environmental Factors and Reproduction 432
Jessica Trowbridge
Patrice Sutton
Tracey J. Woodruff
Linda C. Giudice
- 21 Physiological and Pathophysiological Alterations of the Neuroendocrine Components of the Reproductive Axis 439
Ralf Nass
Kristin D. Helm
William S. Evans
- 22 Polycystic Ovary Syndrome and Hyperandrogenic States 485
R. Jeffrey Chang

23	Female Infertility.....	512	31	Assisted Reproduction	734
	Robert L. Barbieri			Elizabeth S. Ginsburg	
				Catherine Racowsky	
24	Male Infertility.....	538	32	Gamete and Embryo Manipulation.....	774
	Paul J. Turek			Charles L. Bormann	
25	Endocrine Disturbances Affecting Reproduction	551	33	Fertility Preservation	791
	Alice Y. Chang			Francesca E. Duncan	
	Richard J. Auchus			Robert E. Brannigan	
				Teresa K. Woodruff	
26	Endometriosis.....	565	34	Laboratory Assessment	822
	Robert Taylor			Enrico Carmina	
	Dan I. Lebovic			Frank Z. Stanczyk	
27	Benign Uterine Diseases	586		Rogerio A. Lobo	
	Zaraq Khan		35	Pelvic Imaging in Reproductive Endocrinology	851
	Elizabeth A. Stewart			Dominique de Ziegler	
28	Endocrine Diseases of Pregnancy.....	604		Isabelle Streuli	
	Andrea G. Edlow			Pietro Santulli	
	Errol R. Norwitz			Charles Chapron	
29	Hormone Responsive Cancers	651	36	Contraception	890
	Richard J. Santen			Courtney A. Schreiber	
	Linda R. Duska			Kurt Barnhart	
	Stephen H. Culp				
				Index	909

PART 3

REPRODUCTIVE TECHNOLOGIES

30	Medical Approaches to Ovarian Stimulation for Infertility	701
	Bart C.J.M. Fauser	

PART 1

**ENDOCRINOLOGY
OF
REPRODUCTION**

