

SCIENTIFIC FOUNDATIONS
OF
UROLOGY

THIRD EDITION

GEOFFREY D CHISHOLM
WILLIAM R FAIR

Scientific Foundations of Urology

THIRD EDITION

Edited by

GEOFFREY D. CHISHOLM, ChM, FRCSE, FRCS

Professor of Surgery, University of Edinburgh;

President, Royal College of Surgeons of Edinburgh;

Honorary Consultant Urological Surgeon, Western General Hospital, Edinburgh;

Director, Nuffield Transplant Unit, Edinburgh;

Honorary Senior Lecturer, Institute of Urology, University of London

and

WILLIAM R. FAIR, MD

Professor of Surgery, Cornell University Medical College, New York City, New York;

Attending Surgeon and Chief, Urology Service, Memorial Sloan-Kettering Cancer Center, New York City, New York

Member, Sloan-Kettering Cancer Research Institute, New York City, New York



Heinemann Medical Books
Oxford

Published simultaneously by:



Year Book Medical Publishers, Inc.
Chicago



First published 1976 }
Second edition 1982 } by William Heinemann Medical Books Ltd.

Third edition 1990 by **Heinemann Medical Books**

An imprint of Heinemann Professional Publishing Ltd.,
Halley Court, Jordan Hill, Oxford OX2 8EJ, UK
OXFORD-LONDON-SINGAPORE-NAIROBI-IBADAN-KINGSTON

and **Year Book Medical Publishers Inc.**

200 North LaSalle Street, Chicago, Illinois 60601, USA
CHICAGO-LONDON-BOCA RATON-LITTLETON, MASS.

© Geoffrey D. Chisholm and William R. Fair 1990

This book is copyrighted in England and may not be reproduced by
any means, in whole or in part. Application with regard to
reproduction should be directed to Heinemann Medical Books.

Distributed in Continental North, South and Central America,
Hawaii, Puerto Rico and The Philippines by Year Book Medical Publishers Inc.

British Library Cataloguing in Publication Data

Scientific foundations of urology. — 3rd ed.

1. Medicine, Urology

I. Chisholm, Geoffrey, D. (Geoffrey Duncan) II. Fair, William R.
616.6

(UK) ISBN 0-433-05497-2

Library of Congress Cataloging-in-Publication Data

Scientific foundations of urology/[edited by] G. D. Chisholm, William R. Fair.—3rd ed.

Includes bibliographical references.

1. Urology. 2. Genitourinary organs—Diseases.

I. Chisholm, Geoffrey D. II. Fair, William R.

[DNLM: 1. Urologic Diseases. WJ 100 S416]

RC871.S4 1990 616.6—dc20

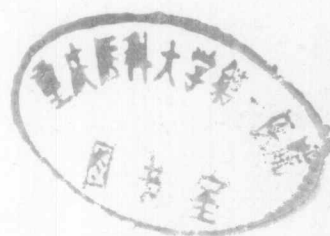
DNLM/DLC 89-22487

for Library of Congress CIP

(USA) ISBN 0-8151-1675-6

SCIENTIFIC FOUNDATIONS
OF UROLOGY

重庆医科大学



LIST OF CONTRIBUTORS

- D. C. ANDERSON, MD, MSc, FRCP, MRCPPath**
Professor of Endocrinology, University of Manchester
Department of Medicine; Hon Consultant Physician,
Hope Hospital, Salford.
- G. BARTSCH, MD**
Professor and Head of Department of Urology, Univer-
sity of Innsbruck, Austria.
- JØRGEN G. BERTHELSEN, Dr Med**
Chief Gynaecologist, Central Hospital, Hillerød, Den-
mark, and of Laboratory of Reproductive Biology,
University Department of Obstetrics and Gynaecology,
Rigshospitalet, Copenhagen, Denmark.
- N. J. BLACKLOCK, CVO, OBE, FRCS**
Professor of Urological Surgery, University Hospital of
South Manchester; Director, Lithotripter Unit, Univer-
sity Hospital of South Manchester.
- J. G. BLAIVAS, MD**
Professor of Urology; Vice Chairman, Department of
Urology; Director, Neurourology, College of Physi-
cians and Surgeons, Columbia University, New York
City, New York.
- GEORGE J. BOSL, MD**
Associate Professor of Medicine, Cornell University
Medical College, New York City; Head, Division of
Solid Tumor Oncology, Memorial Sloan-Kettering
Cancer Center, New York City, New York.
- G. S. BRINDLEY, MD, FRCP, HonFRCS, FRS**
Hon Director, MRC Neurological Prostheses Unit,
Institute of Psychiatry; Professor of Physiology,
University of London.
- A. BRÜNGGER, MD**
Department of Pathology, University of Basle, Switzer-
land.
- A. COLIN BUCK, MB, PhD, FRCS**
Consultant Urologist, Glasgow Royal Infirmary.
- A. BUSUTTL, MD, FRCPATH, DMJ (Path)**
Regius Professor of Forensic Medicine, University of
Edinburgh; Hon Consultant Pathologist, Lothian
Health Board.
- JOSEPH L. CAMPS, MD**
Fellow in Urology, University of Texas MD Anderson
Cancer Center, Houston, Texas.
- PETER R. CARROLL, MD**
Assistant Professor of Urology, University of Cali-
fornia School of Medicine, San Francisco, California.
- R. S. K. CHAGANTI, PhD**
Laboratory of Cancer Genetics and Cytogenetics,
Department of Pathology, Memorial Sloan-Kettering
Cancer Center, New York City, New York.
- LINDA CHAMBERLIN, PhD**
Director of Research, Urology Department, School of
Medicine and Biomedical Sciences, State University of
New York at Buffalo, Buffalo, New York.
- G. D. CHISHOLM, ChM, PRCS, FRCS**
Professor of Surgery, University of Edinburgh; Hon
Consultant Urological Surgeon, Western General Hos-
pital, Edinburgh; Hon Senior Lecturer, Institute of
Urology, University of London.
- LELAND W. K. CHUNG, PhD**
Associate Professor of Urology, Biochemistry and
Molecular Biology; Director, Urology Research Labor-
atory, University of Texas MD Anderson Cancer
Center, Houston, Texas.
- DONALD S. COFFEY, PhD**
Professor of Urology, Oncology and Pharmacology,
The Johns Hopkins Oncology Center, Johns Hopkins
Hospital, Baltimore, Maryland.
- NORMAN S. COPLON, MD, FACP**
Clinical Professor of Medicine, Stanford University
School of Medicine, Stanford, California; Director,
Satellite Dialysis Center Inc., San Jose, California.
- M. J. COPTCOAT, MB, FRCSE**
Senior Registrar in Urology, St Mary's Hospital, Ports-
mouth.
- GEORGE F. DANIELS JR., MD**
Physician Specialist, Department of Surgery (Urology),
Stanford University School of Medicine, Stanford,
California.
- JEAN B. DEKERNION, MD**
Professor of Surgery/Urology, Head of Urologic Onco-
logy and Chief of Division of Urology, UCLA School
of Medicine; Director, Genitourinary Oncology Pro-
gram Area, Jonsson Comprehensive Cancer Center,
UCLA, Los Angeles, California.
- J. S. DIXON, BSc, PhD**
Senior Lecturer in Histology, University of Manchester.
- ANDREW C. VON ESCHENBACH, MD**
Professor and Chairman, Department of Urology,
University of Texas MD Anderson Cancer Center,
Houston, Texas; Professor, Graduate School of Bio-
medical Sciences, UT Health Science Center at
Houston; Consulting Professor of Cell Biology, Univer-
sity of Texas MD Anderson Cancer Center, Houston,
Texas.
- WILLIAM R. FAIR, MD**
Professor of Surgery, Cornell University Medical Col-
lege, New York City; Attending Surgeon and Chief,
Urology Service, Memorial Sloan-Kettering Cancer

LIST OF CONTRIBUTORS

- Center, New York City; Member, Sloan-Kettering Cancer Research Institute, New York City, New York.
- JOHN M. FITZPATRICK, MCh, FRCSI**
Consultant Urologist and Professor of Surgery, Mater Misericordiae Hospital and University College, Dublin, Eire.
- JONATHAN D. FLEISCHMANN, MD**
Assistant Professor of Urology, Case Western Reserve University School of Medicine; Attending Urologist, Cleveland Metropolitan General Hospital, Cleveland Veterans Administration Hospital and University Hospitals of Cleveland, Ohio.
- YVES FRADET, MD, FRCSC, MRC Scientist**
Associate Professor of Surgery/Urology; Head of Uro-oncology and of Experimental Uro-oncology Laboratory, Laval University Cancer Research Center, L'Hôtel-Dieu de Quebec, Quebec, Canada.
- H. M. GILLES, MSc, MD, FRCP, FFCM, MD (Hon Causa Karolinska Institute), DSc (Hon Causa Malta)**
Emeritus Professor of Tropical Medicine, University of Liverpool; Senior Research Fellow, Department of Pharmacology and Therapeutics, University of Liverpool.
- J. A. GOSLING, MB, ChB, MD**
Professor and Chairman of Anatomy, Department of Anatomy, Chinese University of Hong Kong, Shatin NT, Hong Kong.
- JOHN T. GRAYHACK, MD**
Herman L. Kretschmer Professor of Urology; Chairman, Department of Urology, Northwestern University Medical School, Chicago, Illinois.
- DONALD P. GRIFFITH, MD**
Professor of Urology, Baylor College of Medicine, Scott Department of Urology, Houston, Texas.
- G. J. GRIFFITHS, MD, FRCR, DCH**
Consultant Radiologist, Royal Gwent and St Woolos Hospital, Newport, Gwent.
- K. M. GRIGOR, BSc, MB, ChB, MD, MRCPPath**
Senior Lecturer in Pathology, University of Edinburgh; Hon Consultant, Lothian Health Board.
- FOUAD K. HABIB, PhD, CChem, FRCS**
Senior Lecturer, University Department of Surgery, Western General Hospital, Edinburgh.
- STEPHEN W. HARDEMAN, MD**
Assistant Professor, Department of Urology, University of Tennessee, Memphis, Tennessee.
- T. B. HARGREAVE, MD, FRCS, FRCSE**
Senior Lecturer, University of Edinburgh; Hon Consultant Urological Surgeon, Western General Hospital, Edinburgh.
- JEAN A. HARVEY, MD**
Assistant Professor, The Center for Mineral Metabolism and Clinical Research and Department of Internal Medicine, University of Texas Southwestern Medical Center, Dallas, Texas.
- JOSEPH M. HAYES, MD**
Staff Urologist, Department of Urology, The Cleveland Clinic Foundation, Cleveland, Ohio.
- HARRY W. HERR, MD**
Associate Attending Surgeon, Urologic Service, Department of Surgery, Memorial Sloan-Kettering Cancer Center; Associate Professor of Surgery, Cornell University Medical College, New York City, New York.
- W. D. W. HESTON, PhD**
Attending Biochemist, Memorial Hospital; Associate Member, Sloan-Kettering Institute for Cancer Research; Director, Urologic Oncology Research Laboratory, Memorial Sloan-Kettering Cancer Center, New York City, New York.
- H. HINTNER, MD**
Assistant Professor, Department of Dermatology, University of Innsbruck, Austria.
- THOMAS M. HOOTON, MD**
Assistant Professor, Department of Medicine, University of Washington Affiliated Hospitals, Seattle, Washington.
- R. HÖPFL, MD**
Department of Dermatology, University of Innsbruck, Austria.
- HEDVIG HRICAK, MD**
Professor of Radiology and Urology; Chief, Uroradiology Section, University of California, San Francisco, California.
- JOHN T. ISAACS, MD, PhD**
Associate Professor of Oncology and Urology, The Johns Hopkins Oncology Center, Johns Hopkins Hospital, Baltimore, Maryland.
- K. T. ISON, MA, MSc, PhD**
Senior Physicist to St Peter's Hospitals; Hon Lecturer, Institute of Urology, University of London.
- R. W. G. JOHNSON, MB, BS, MS, FRCS**
Reader in Surgery, University of Manchester; Consultant Surgeon, Manchester Royal Infirmary; Hon Consultant Surgeon, Royal Manchester Children's Hospital; Director of Transplantation, North West Regional Transplant Service.
- LOWELL R. KING, MD**
Professor of Surgery; Head, Section of Pediatric Urology, Division of Urology, Duke University Medical Center, Durham, North Carolina.
- ROGER S. KIRBY, MA, MD, FRCS**
Consultant Urologist, St Bartholomew's Hospital and Homerton Hospital, London.
- JOHN N. KRIEGER, MD**
Associate Professor, Department of Urology, University of Washington School of Medicine, Seattle, Washington.
- RICHARD A. LAFAYETTE, MD**
Fellow in Nephrology, Stanford University, California.
- M. LAIDLAW, MB, ChB**
Formerly Consultant Bacteriologist, Southern General Hospital and Scottish Mycobacteria Reference Laboratory, Glasgow.
- PAUL H. LANGE, MD**
Professor and Chairman, Department of Urology, University of Washington Medical Center, Seattle, Washington.
- D. M. LARGE, MD, MRCP**
Consultant Physician, Cumberland Infirmary, Carlisle.

DEBORAH J. LIGHTNER, MD

Private Practice; previously Fellow in Urologic Oncology, Veterans Administration Medical Center, University of Minnesota, Minneapolis, Minnesota.

M. G. LUCAS, MB, ChM, FRCS

Senior Registrar in Urology, Department of Urology, Western General Hospital, Edinburgh.

TOM F. LUE, MD

Associate Professor of Urology, University of California School of Medicine, San Francisco, California.

G. N. LUMB, MB, BS(Lond), FRCS

Consultant Urological Surgeon to the Somerset Health Authority; Representative for the Royal College of Surgeons of England to the British Standards Institution Committee on Medical Electrical Apparatus.

J. S. MALPAS, BSc, MBBS, DPhil, FRCP, FRCR

Professor of Medical Oncology, St Bartholomew's Hospital, London.

T. McNICHOLAS, MB, FRCS

Senior Registrar to St Peter's Hospitals, London.

E. M. MEARES JR., MD, FACS, FIDSA

Chairman and Charles M. Whitney Professor, Division of Urology, Tufts University School of Medicine; Chairman, Department of Urology, New England Medical Center Hospitals, Boston, Massachusetts.

M. V. MERRICK, MA, BM, BCh, MSc, FRCR

Consultant in Nuclear Medicine, Western General Hospital, Edinburgh; Senior Lecturer, University of Edinburgh Departments of Medicine and Radiodiagnosis.

R. A. MILLER, MB, BS, FRCS, MS

Consultant Urological Surgeon, Whittington and Royal Northern Hospitals; Hon Senior Lecturer, Institute of Urology; Postgraduate Dean, Royal Northern Hospital, London.

D. B. MOFFAT, VRD, MD, FRCS Hon FChS

Emeritus Professor of Anatomy, University College, Cardiff.

H. D. M. MOORE, BSc, PhD

Head of Gamete Biology, MRC/AFRC Comparative Physiology Research Group, Institute of Zoology, Zoological Society of London.

T. R. MORGAN, MD

Urology Fellow, Memorial Hospital, New York City, New York.

ROBERT J. MOTZER, MD

Clinical Assistant Physician, Memorial Sloan-Kettering Cancer Center, New York City, New York.

GREGORY J. NEERHUT, MB, BS, FRACS(Urol)

Formerly Fellow, Department of Urology, Baylor College of Medicine, Houston, Texas; Currently Visiting Urologist, Royal Melbourne Hospital, Melbourne, Australia.

ANDREW C. NOVICK, MD

Chairman, Department of Urology; Head, Section of Renal Transplantation; Head, The Organ Transplantation Center, The Cleveland Clinic Foundation, Cleveland, Ohio.

P. H. O'REILLY, MD, FRCS

Consultant Urological Surgeon, Department of Urology, Stepping Hill Hospital, Stockport.

MICHAEL A. PATTON, MB, MA, MSc, MRCP, DCh

Consultant and Senior Lecturer in Clinical Genetics, St George's Hospital Medical School, London.

W. B. PEELING, MA, MB, BChir, FRCS

Consultant Urological Surgeon, South Gwent Hospitals, St Woolos and Royal Gwent Hospitals, Newport, Gwent.

JEFFREY PETERSEN, MB, ChB, MD, MRCP

Assistant Professor, Medicine/Nephrology, Stanford University, California; Director, Clinical Nephrology, Stanford University; Director, Dialysis Programs, Palo Alto Veterans Administration Center, Palo Alto, California.

ALPHONSE PFAU, MD, FACS

Professor and Head, Department of Urology, Hebrew University Hadassah Medical Center, Jerusalem, Israel.

J. R. PINCOTT, MD, FRCPath

Group Director, Pathology and Toxicology, Smith Kline and French Research Ltd Welwyn; Hon Consulting Pathologist, The Hospitals for Sick Children, Great Ormond St., London.

DOV PODE, MD

Senior Lecturer, Department of Urology, Hadassah Medical Center, Jerusalem, Israel.

GLENN M. PREMINGER, MD

Associate Professor, The Center for Mineral Metabolism and Clinical Research and the Division of Urology, Department of Surgery, University of Texas, Southwestern Medical Center, Dallas, Texas.

MARTIN I. RESNICK, MD

Professor and Chairman, Division of Urology, Case Western Reserve University School of Medicine; Chief of Urology, University Hospitals of Cleveland; Attending Urologist, Cleveland Metropolitan General Hospital and Cleveland Veterans Administration Hospital, Ohio.

VICTOR E. REUTER, MD

Assistant Attending Pathologist, Memorial Sloan-Kettering Cancer Center; Assistant Professor of Pathology, Cornell University Medical College, New York City, New York.

BRIAN RICHARDS, MD, FRCS

Consultant Urologist, York District Hospital.

ALASTAIR W. S. RITCHIE, BSc, MB, ChB, FRCSE, MD

Senior Lecturer in Urology, University of Edinburgh; Hon Consultant Urological Surgeon, Royal Infirmary, Edinburgh.

H. P. ROHR, MD

Professor of Urology, University of Basle, Switzerland.

G. ALAN ROSE, MA, DM, FRCP, FRCPath, FRSC, CChem

Consultant Chemical Pathologist to St Peter's Hospitals, London, and Royal National Orthopaedic Hospital, Stanmore; Hon Senior Lecturer, Institute of Urology, University College, London.

ANTHONY J. SCHAEFFER, MD

Professor of Urology, Northwestern University Medical School; Attending Urologist, Northwestern Memorial Hospital, Chicago, Illinois.

FRITZ H. SCHRÖDER, MD

Chairman, Department of Urology, Academic Hospital; Director, Institute of Urology, Erasmus University, Rotterdam, The Netherlands.

H. U. SCHWEIKERT, MD

Professor of Intern Medicine, University of Bonn, Federal Republic of Germany.

THOMAS SHERWOOD, MB, MA, DCh, FRCP, FRCR

Professor of Radiology and Clinical Dean, University of Cambridge.

NIELS E. SKAKKEBAEK, Dr Med

Professor, Laboratory of Reproductive Biology, Rigshospitalet and Department of Paediatrics, Hvidovre Hospital, University of Copenhagen, Denmark.

R. G. SKEET, BSc

Deputy Director of Information, Herefordshire Health Authority, Hereford.

MARK S. SOLOWAY, MD

Professor, Department of Urology; Chief, Urologic Oncology, University of Tennessee, Memphis, Tennessee.

R. ERNEST SOSA, MD

Assistant Professor, Surgery/Urology, Cornell University Medical College, New York City, New York.

ODED SPERLING, MSc, PhD

Professor in Chemical Pathology; Dean, Sackler Faculty of Medicine, Tel Aviv University; Director, Clinical Biochemistry, Beilinson Medical Center, Petah-Tikva, Israel.

GERT-JAN VAN STEENBRUGGE, PhD

Staff Member/Research Associate, Department of Urology, Medical Faculty, Erasmus University, Rotterdam, The Netherlands.

NORMAN W. STRUTHERS, ChM, FRCS, FRCSC, FRCSE

Urologist, St Michael's Hospital; Associate Professor, University of Toronto, Canada.

GERALD SUFRIN, MD

Professor and Chairman, Department of Urology, School of Medicine and Biomedical Sciences, State University of New York at Buffalo, Buffalo, New York.

EMIL A. TANAGHO, MD

Professor and Chairman, Department of Urology, University of California School of Medicine, San Francisco, California.

BERNARD TÊTU, MD, FRCP(C) American Board of Pathology (Anatomic Pathology)

Assistant Professor of Pathology, Université Laval; Assistant Pathologist, L'Hôtel-Dieu de Québec, Canada.

D. G. THOMAS, FRCS

Consultant Urologist, Spinal Unit, Lodge Moor Hospital, Sheffield.

F. D. THOMPSON, MA, MB, BChir, FRCP

Consultant Nephrologist, St Peter's Group of Hospitals; Consultant Nephrologist, Harefield and Mount Vernon Hospitals.

IAN M. THOMPSON Jr., MD

Staff Urologist and Assistant Chief of Department of Clinical Investigation, Brooke Army Medical Center, Joint Military Medical Command, San Antonio, Texas; Consultant in Urology, Darnell Army Hospital, Fort Hood, Texas; Clinical Assistant Professor, Uniformed Services University of the Health Sciences, Bethesda, Maryland.

RICHARD TURNER-WARWICK, DSc, DM(Oxon), FRCP, MCh, FRCS, FACS, FRACS(Hon)

Senior Surgeon, The Middlesex Hospital; Senior Consultant Urological Surgeon, The St Peter's Group Hospitals; Senior Lecturer, Institute of Urology, University of London.

E. DARRACOTT VAUGHAN JR., MD

James J. Colt Professor of Urology in Surgery, Cornell University Medical College; Attending Surgeon, New York Hospital, Memorial Sloan-Kettering Cancer Center; Visiting Physician, The Rockefeller University Hospital, New York City, New York.

ANDRE DE VRIES, MD, PhD

Emeritus Professor of Medicine, Sackler Faculty of Medicine, Tel Aviv University, Israel.

D. M. A. WALLACE, FRCS

Consultant Urologist, Queen Elizabeth Hospital, Birmingham.

R. W. E. WATTS, MD, DSc, PhD, FRCP, FRSC

Visiting Professor, Royal Postgraduate Medical School; Hon Consultant Physician, Hammersmith Hospital, London.

J. N. WEBB, MA, MD(Cantab), FRCPE

Consultant Pathologist and Head of Department of Pathology, Western General Hospital, Edinburgh.

ALAN J. WEIN, MD

Professor and Chairman, Division of Urology, University of Pennsylvania School of Medicine; Chief of Urology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania.

ROBERT H. WHITAKER, MD, MChir, FRCS

Consultant Paediatric Urologist, Addenbrooke's Hospital, Cambridge; Associate Lecturer, University of Cambridge; Hon Senior Clinical Lecturer, Institute of Urology, University of London.

J. M. A. WHITEHOUSE, MA, MD, FRCP

Professor of Medical Oncology and Hon Consultant Physician, CRC Medical Oncology Unit, Southampton General Hospital.

J. E. A. WICKHAM, BSc, MS, FRCS

Consultant Urologist to St Peter's Hospitals; Director, Academic Unit, Institute of Urology, University of London; Civilian Consultant Advisor to the Royal Air Force.

C. J. WILLIAMS, DM, FRCP

Senior Lecturer and Hon Consultant Physician, CRC Medical Oncology Unit, Southampton General Hospital.

PREFACE TO THE FIRST EDITION

What are the Scientific Foundations of Urology? The answer to this seemingly simple question has proved to be surprisingly elusive. Historically it cannot be claimed that urology has been founded on science: it originated as a craft. Our recent better understanding of disease and our better management of individual patients have indeed stemmed from advances in physiology and pathology, but even now we can scarcely assert that these sciences as yet provide a solid bedrock on which to build our foundations. Science is today better conceived as an activity rather than as an agreed compendium of knowledge: the scientific process involves the study of a problem by setting up hypotheses which can then be tested, confirmed or refuted by observation, measurement and experiment. Those hypotheses which seem to be confirmed then form the basis on which the scientist develops new studies and the clinician devises his treatment. But the solidity of the confirmation is only in proportion to the depths of the investigation: new hypotheses and new observations may always demand a totally new construction with a different concept of disease and its management, so that only in the simplest of descriptive sciences can we claim to have reached any solid foundation.

What can be asserted with some confidence is that the scientific method has enormously enhanced the efficacy of our treatment of urological disease and it is in the belief that practice should now be founded on science that we present this miscellany of contributions. We cannot hope that the ideas here set out will constitute the truth for all time, but they form the framework within which the scientific clinician must work for the present.

The book is primarily intended for urological surgeons, those in practice as well as those in training. It aims to complement rather than compete with the numerous excellent textbooks of urology which cover so completely the clinical, diagnostic and operative aspects of our topic. It aims particularly at pathophysiology, the newer aspects of histopathology and oncology but deals too with the science-based technology of endoscopic instruments.

We recognize that the distinction between medicine and surgery is blurred and although we are dealing primarily with diseases amenable to surgical treatment, many chapters have a medical flavour. Those which are of most importance to the nephrologist have been grouped together in the first volume, though it must be emphasized that this is in no way a textbook of nephrology. The second volume deals with disorders of the urinary tract with a more specifically surgical aspect, and with neoplastic diseases, but this volume too has its medical interest for the endocrinologist and the chemotherapist.

The current scope of scientific urology, and therefore of our project, has proved to be enormous and inevitably much has had to be omitted. Articles have had to be ruthlessly pruned and some of those originally planned have been regretfully laid aside; thus embryology, even though so important in the consideration of congenital anomalies which make up the bulk of paediatric surgery, would have almost filled a third volume and has had to be omitted.

To our authors we wish to express our gratitude for their contributions to knowledge and to these volumes: we ask their forgiveness for delays and for the mutilating surgery which we have had to inflict on their articles in order to preserve the life of the book as a whole. To our publishers, we

PREFACE

acknowledge our indebtedness for the opportunity to produce a work which we believe breaks new ground and we thank them for their ready understanding of our problems. We thank too our many secretaries and illustrators for their patience and industry in the labour of this production.

For our readers we hope that these volumes will be seen not simply as a source of instruction and reference but as an indication of the scientific possibilities of what was once the craft of urology. These articles should represent a starting point rather than a final statement and if our readers find anything to criticize in the work of the authors, we shall at least have been successful in providing a stimulus to think afresh. They will no doubt find much to criticize in the work of the editors, who can only hope that there will be sufficient interest in the book to make possible the correction of errors by a second edition.

February, 1976

David Innes Williams
Geoffrey D. Chisholm

PREFACE TO THE THIRD EDITION

Seven years after the 2nd edition, it is more than evident that the scientific foundations of urology have undergone such great changes both in content and emphasis that only a major revision of the book could cope with these changes. In order to contain the size, we have had to omit some chapters and, where appropriate, incorporate some of that material into either major revisions or into completely new chapters. Thus, the section on the kidney and its investigation has been rewritten and new contributors have been brought in to all sections of the book. We are greatly indebted to the previous authors for their thorough revisions and to our new authors for their excellent contributions.

The purpose of this book is unchanged: it is to identify the ever-growing and ever-changing scientific foundations of urology and to present that science in such a way that we can all gain from this knowledge. The scientific method requires that we continually review and evaluate the basis of our practice. It is becoming near impossible to gain an up-to-date perspective of all the scientific aspects of our specialty. Even a book of this size remains selective, but we have continued our aim to emphasize biology, pathophysiology, histopathology and technology. Subspecialization is an increasing trend in all areas of medical practice and we must be alert to the risks for those with limited horizons. A further aim of this book, therefore, is to provide our readers with facts, ideas and concepts from which they can develop their own opinions and thereby improve their clinical practice.

The preparation of this type of book can be lengthier than one would wish, but we are greatly indebted to all our authors and their secretaries for the prompt handling of so much material. Central to the successful completion of this revision is Mrs Ann Kirk of Heinemann Medical whose meticulous professionalism has guaranteed the quality of all three editions: we are deeply in debt to her for all that she has done for this volume.

September, 1989

Geoffrey D. Chisholm
William R. Fair

CONTENTS

List of Contributors	ix
Preface to First Edition	xiii
Preface to Third Edition	xiv

SECTION I

KIDNEY AND INVESTIGATION

1. FUNDAMENTALS OF RENAL ANATOMY J. S. DIXON and J. A. GOSLING	1
2. FUNDAMENTALS OF RENAL PHYSIOLOGY R. A. LAFAYETTE and J. PETERSEN	10
3. IMAGING: RADIOLOGY THOMAS SHERWOOD	17
4. COMPUTED TOMOGRAPHY AND ULTRASOUND OF THE KIDNEY JONATHAN D. FLEISCHMANN and MARTIN I. RESNICK	21
5. MAGNETIC RESONANCE IMAGING HEDVIG HRICAK and PETER R. CARROLL	29
6. RADIONUCLIDE RENAL STUDIES P. H. O'REILLY	40
7. LABORATORY AND BIOCHEMICAL TESTS F. D. THOMPSON	49

SECTION II

RENAL FAILURE, TRANSPLANTATION, HYPERTENSION

8. PATHOPHYSIOLOGY OF ACUTE AND CHRONIC RENAL FAILURE NORMAN S. COPLON	54
9. PATHOPHYSIOLOGY OF OBSTRUCTIVE UROPATHY G. D. CHISHOLM	59
10. VESICoureTERAL REFLUX LOWELL R. KING	66
11. THE IMMUNOLOGY OF RENAL TRANSPLANTATION JOSEPH M. HAYES	81
12. THE DONOR KIDNEY R. W. G. JOHNSON	87
13. RENAL TRANSPLANTATION: IMMUNOSUPPRESSION, REJECTION AND RESULTS JOSEPH M. HAYES and ANDREW C. NOVICK	102
14. RENAL HYPERTENSION R. ERNEST SOSA and E. DARRACOTT VAUGHAN JR.	107

SECTION III

URINARY TRACT INFECTION

15. ROLE OF BACTERIAL ADHERENCE IN URINARY TRACT INFECTIONS ANTHONY J. SCHAEFFER	123
16. URINARY TRACT INFECTIONS ALPHONSE PFAU	131
17. BACTERAEMIA, SEPTICAEMIA AND PROPHYLAXIS IN UROLOGY JOHN M. FITZPATRICK	142
18. RENAL TUBERCULOSIS M. LAIDLAW	148

- | | | |
|-----|--------------------------------------|-----|
| 19. | PARASITIC INFECTIONS | 152 |
| | H. M. GILLES | |
| 20. | SEXUALLY TRANSMITTED DISEASES | 157 |
| | THOMAS M. HOOTON and JOHN N. KRIEGER | |

SECTION IV UROLITHIASIS

- | | | |
|-----|---|-----|
| 21. | UROLITHIASIS: EPIDEMIOLOGY | 170 |
| | N. J. BLACKLOCK | |
| 22. | RISK FACTORS IN IDIOPATHIC STONE DISEASE | 176 |
| | A. COLIN BUCK | |
| 23. | CALCIUM METABOLISM: NORMAL AND ABNORMAL | 193 |
| | GLENN M. PREMINGER and JEAN A. HARVEY | |
| 24. | INFECTION—INDUCED STONES | 200 |
| | GREGORY J. NEERHUT and DONALD P. GRIFFITH | |
| 25. | CYSTINURIA/XANTHINURIA | 209 |
| | R. W. E. WATTS | |
| 26. | URIC ACID STONE FORMATION: CONCEPTS OF AETIOLOGY AND TREATMENT | 216 |
| | ANDRE DE VRIES and ODED SPERLING | |
| 27. | MEDICAL INVESTIGATION AND SCREENING PROCEDURES FOR URINARY STONES | 221 |
| | G. ALAN ROSE | |

SECTION V GENETICS AND DEVELOPMENT

- | | | |
|-----|--|-----|
| 28. | GENETICS AND UROLOGY | 224 |
| | MICHAEL A. PATTON | |
| 29. | DEVELOPMENT OF THE UROGENITAL SYSTEM IN THE MALE | 231 |
| | D. B. MOFFAT | |
| 30. | DEVELOPMENTAL ABNORMALITIES OF THE UROGENITAL SYSTEM | 242 |
| | D. B. MOFFAT | |

SECTION VI THE URINARY TRACT

- | | | |
|-----|---|-----|
| 31. | THE PHYSIOLOGY OF THE URETER | 257 |
| | NORMAN W. STRUTHERS | |
| 32. | PATHOPHYSIOLOGY OF THE URETER | 260 |
| | ROBERT H. WHITAKER | |
| 33. | ANATOMY OF THE BLADDER AND URETHRA | 266 |
| | J. A. GOSLING and J. S. DIXON | |
| 34. | MECHANISM OF MICTURITION | 273 |
| | J. G. BLAIVAS | |
| 35. | THE URINARY TRACT FOLLOWING SPINAL CORD INJURY | 286 |
| | D. G. THOMAS and M. G. LUCAS | |
| 36. | PHARMACOLOGY OF THE LOWER URINARY TRACT | 299 |
| | ALAN J. WEIN | |
| 37. | URODYNAMIC STUDIES AND THEIR EFFECT UPON MANAGEMENT | 308 |
| | RICHARD TURNER-WARWICK and ROGER S. KIRBY | |
| 38. | URINARY INCONTINENCE: PATHOLOGY AND PRINCIPLES OF TREATMENT | 324 |
| | M. G. LUCAS | |
| 39. | CONTROL OF THE BLADDER AND URETHRAL SPHINCTERS BY SURGICALLY IMPLANTED ELECTRICAL STIMULATORS | 336 |
| | G. S. BRINDLEY | |

SECTION VII THE PROSTATE

- | | | |
|-----|------------------|-----|
| 40. | SURGICAL ANATOMY | 340 |
| | N. J. BLACKLOCK | |

CONTENTS

vii

41.	PHYSIOLOGY OF PROSTATIC SECRETIONS	351
	GEORGE F. DANIELS JR. and JOHN T. GRAYHACK	
42.	PROSTATE: MECHANISMS OF NORMAL AND ABNORMAL METABOLISM	358
	FOUAD K. HABIB	
43.	PATHOGENESIS OF BENIGN PROSTATIC HYPERPLASIA: MORPHOMETRIC AND BIOCHEMICAL STUDIES	366
	G. BARTSCH, A. BRÜNGGER, H. U. SCHWEIKERT, H. HINTNER, R. HÖPFL and H. P. ROHR	
44.	PROSTATITIS	373
	E. M. MEARES JR.	

SECTION VIII

GENITAL TRACT, FERTILITY, POTENCY

45.	ENDOCRINE FUNCTION OF THE TESTIS: NORMAL AND ABNORMAL	379
	D. C. ANDERSON and D. M. LARGE	
46.	SPERMATOGENESIS	391
	NIELS E. SKAKKEBAEK and JØRGEN G. BERTHELSEN	
47.	THE EPIDIDYMIS	399
	H. D. M. MOORE	
48.	FERTILITY AND INFERTILITY	410
	T. B. HARGREAVE	
49.	PHYSIOLOGY OF PENILE ERECTION	420
	EMIL A. TANAGHO and TOM F. LUE	

SECTION IX

GENERAL ONCOLOGY

50.	EPIDEMIOLOGY OF UROGENITAL TUMOURS	427
	R. G. SKEET	
51.	TUMOUR MARKERS IN UROLOGICAL ONCOLOGY	433
	DEBORAH J. LIGHTNER and PAUL H. LANGE	
52.	BONE SCINTIGRAPHY FOR UROLOGICAL CANCERS	438
	M. V. MERRICK	
53.	IMAGING IN THE PELVIS	446
	W. B. PEELING and G. J. GRIFFITHS	
54.	CANCER BIOLOGY	459
	LELAND W. K. CHUNG, JOSEPH L. CAMPS and ANDREW C. VON ESCHENBACH	
55.	THE BIOLOGY OF SOLID TUMOR METASTASIS	474
	T. R. MORGAN and W. D. W. HESTON	
56.	CYTOGENETICS: CHROMOSOMAL ABNORMALITIES IN UROLOGIC TUMORS	481
	PETER R. CARROLL and R. S. K. CHAGANTI	
57.	PRINCIPLES OF ANTICANCER CHEMOTHERAPY	490
	C. J. WILLIAMS and J. M. A. WHITEHOUSE	
58.	CLINICAL TRIALS	508
	BRIAN RICHARDS	

SECTION X

SPECIAL ONCOLOGY: KIDNEY

59.	HISTOPATHOLOGY OF RENAL CARCINOMA	516
	YVES FRADET and BERNARD TÊTU	
60.	EXPERIMENTAL MODELS OF RENAL PARENCHYMAL NEOPLASMS	523
	LINDA CHAMBERLIN and GERALD SUFRIN	
61.	SYSTEMIC EFFECTS	533
	G. D. CHISHOLM	
62.	CYTOTOXIC THERAPY FOR RENAL TUMOURS	536
	J. S. MALPAS	
63.	IMMUNOBIOLOGY OF RENAL CARCINOMA	540
	ALASTAIR W. S. RITCHIE and J. B. DE KERNION	

SECTION XI

SPECIAL ONCOLOGY: UROTHELIUM

- | | | |
|-----|--|-----|
| 64. | HISTOPATHOLOGY OF BLADDER CANCER | 549 |
| | J. N. WEBB | |
| 65. | DEVELOPMENT OF BLADDER CANCER | 561 |
| | D. M. A. WALLACE | |
| 66. | ANIMAL MODELS IN BLADDER CANCER RESEARCH | 567 |
| | MARK S. SOLOWAY and STEPHEN W. HARDEMAN | |
| 67. | OCCUPATIONAL AND ENVIRONMENTAL FACTORS IN BLADDER CANCER | 576 |
| | IAN M. THOMPSON JR. and WILLIAM R. FAIR | |
| 68. | THE BIOLOGY OF UROTHELIAL TUMORS | 582 |
| | DOV PODE and WILLIAM R. FAIR | |
| 69. | IMMUNOBIOLOGY AND IMMUNOTHERAPY OF BLADDER CANCER | 590 |
| | HARRY W. HERR | |

SECTION XII

SPECIAL ONCOLOGY: PROSTATE

- | | | |
|-----|--|-----|
| 70. | HISTOPATHOLOGY OF PROSTATIC CANCER | 598 |
| | A. BUSUTTL | |
| 71. | ANIMAL MODEL SYSTEMS FOR THE STUDY OF PROSTATIC CANCER | 613 |
| | JOHN T. ISAACS and DONALD S. COFFEY | |
| 72. | BASIS OF ENDOCRINE MANAGEMENT OF HUMAN PROSTATIC CARCINOMA | 620 |
| | FRITZ H. SCHRÖDER and GERT-JAN VAN STEENBRUGGE | |

SECTION XIII

SPECIAL ONCOLOGY: TESTIS

- | | | |
|-----|--|-----|
| 73. | PATHOLOGY OF TESTICULAR TUMOURS | 632 |
| | K. M. GRIGOR | |
| 74. | THE BIOLOGY OF GERM CELL TUMORS | 641 |
| | ROBERT J. MOTZER, VICTOR E. REUTER, R. S. K. CHAGANTI and GEORGE J. BOSL | |
| 75. | SEX CORD-STROMAL (GONADAL STROMAL) TUMORS OF THE TESTIS | 648 |
| | VICTOR E. REUTER | |

SECTION XIV

SPECIAL ONCOLOGY: EMBRYONAL TUMOURS

- | | | |
|-----|-------------------------------|-----|
| 76. | RHABDOMYOSARCOMA IN CHILDHOOD | 654 |
| | J. R. PINCOTT | |

SECTION XV

OPTICS, DIATHERMY, LASERS, STONE DISINTEGRATION

- | | | |
|-----|--|-----|
| 77. | THEORY, DESIGN AND USE OF UROLOGICAL ENDOSCOPES | 659 |
| | R. A. MILLER | |
| 78. | SURGICAL DIATHERMY IN UROLOGICAL PRACTICE | 666 |
| | G. N. LUMB | |
| 79. | PRINCIPLES OF LASERS AND THEIR USE IN UROLOGY | 674 |
| | M. J. COPTCOAT, T. McNICHOLAS and J. E. A. WICKHAM | |
| 80. | PRINCIPLES OF STONE FRAGMENTATION | 679 |
| | M. J. COPTCOAT, K. T. ISON and J. E. A. WICKHAM | |

Section I

KIDNEY AND INVESTIGATION

1. FUNDAMENTALS OF RENAL ANATOMY

J. S. DIXON and J. A. GOSLING

Gross anatomy of the kidneys

Structure of the kidneys

- The nephron
- Collecting tubule
- Juxtaglomerular apparatus
- Macula densa
- Renal interstitium
- Blood vessels
- Innervation
- Lymphatics

GROSS ANATOMY OF THE KIDNEYS

Each kidney is of characteristic shape possessing superior and inferior poles, a gently convex lateral border and an indented medial border. The anterior and posterior surfaces are usually smoothly convex although marked lobulation may occasionally persist into adult life. The kidney of an adult weighs 135–150 g and measures approximately 11 cm from pole to pole; 6 cm from lateral to medial border and 3 cm from anterior to posterior surface. Usually, however, the left kidney is longer and more slender than the right. The medial border of each kidney presents an oval aperture, the hilus, which is traversed by the proximal parts of the urinary tract and by the renal vessels, lymphatics and nerves. The kidneys lie in the retroperitoneal tissues and their positions are influenced by the topography of the posterior abdominal musculature. The kidneys are applied to the medial slopes of the paravertebral gutters and, as a consequence, their anterior surfaces are also directed slightly laterally (Fig. 1). The diverging lateral borders of the psoas major muscles cause relatively wide separation of the inferior poles of the kidneys; in addition the anterior curve of the lumbar spine results in the inferior poles lying on a more anterior plane than the superior poles.

Each kidney is covered by an investment of fibrous tissues, the renal capsule. Within its fibrous capsule each kidney is embedded in a mass of adipose tissue lying between the peritoneum and the posterior abdominal wall. Many discrepancies are evident in current literature when descriptions of this adipose tissue and its associated fascial layers are compared. These accounts differ probably because of individual variation in the amount of fat which may occur around the kidneys. Furthermore, the fascial

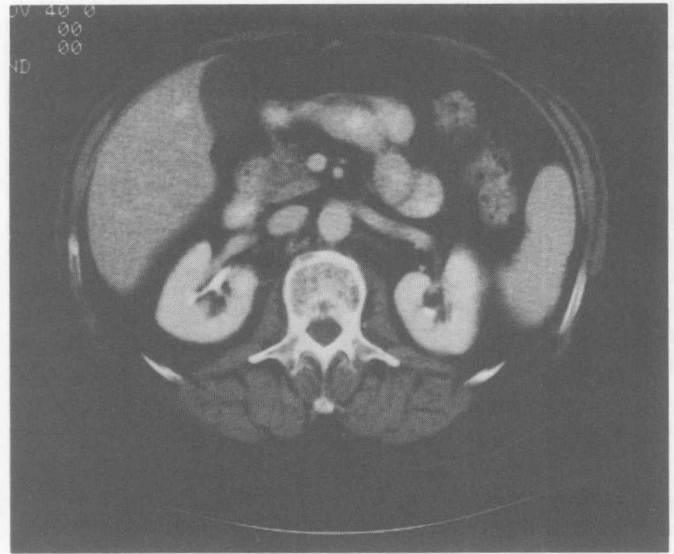


FIG. 1. A CT scan at the level of L1 showing the position of the kidneys lying in the paravertebral gutters. (By courtesy of Professor I. Isherwood, Department of Diagnostic Radiology, University of Manchester.)

layers may not always be easily defined either in the operating theatre or at postmortem examination. Confusion has also resulted from the diversity of terms which have been employed to describe essentially the same tissue planes and fascial layers. In the present text the fat immediately adjacent to the renal capsule is named the perirenal fat (*alternative*: perinephric fat). This adipose tissue is enclosed by the renal fascia (*alternative*: perinephric fascia) which is itself covered anteriorly and posteriorly by the pararenal fat (*alternative*: pararenal body).

The renal fascia possesses anterior and posterior layers which subdivide the retroperitoneal tissues on each side of the midline into three potential spaces: (1) The posterior space (posterior pararenal space) contains a quantity of pararenal fat which can be traced laterally into the anterolateral abdominal wall where it is in continuity with a layer of adipose tissue lying between the transversalis fascia and the peritoneum. (2) The intermediate space is the perirenal space and contains the kidney and suprarenal together with the perirenal fat. (3) The anterior space (anterior pararenal space) is a more extensive compartment and, furthermore, it extends across the midline from

one side of the abdomen to the other, unlike the posterior and intermediate spaces. The anterior space is bounded by the anterior layer of renal fascia of each kidney and by the parietal peritoneum. It contains the ascending and descending colon, the duodenal loop and the pancreas. The anterior and posterior layers of renal fascia merge superior to the suprarenal gland, where they become continuous with the diaphragmatic fascia. Traced medially, the anterior layer blends with the connective tissue around the aorta and inferior vena cava, while the posterior layer fuses with the psoas fascia. Inferior to the kidney the two layers of renal fascia continue into the iliac fossa in the shape of a cone whose apex is directed inferiorly. In this region the two layers are relatively thin and ill-defined. The ureter leaves the perirenal space obliquely by piercing the medial aspect of the fascial cone. From the lateral side of the cone, the two layers of renal fascia fuse to form a single layer, the lateroconal fascia, which can be traced laterally, posterior to the ascending and descending colon, before attaching to the peritoneum of the paracolic gutter.

Since the renal fascia forms a closed compartment, it limits the spread of effusions and exudates originating from the kidney. Such effusions are prevented from crossing the midline and tend to spread inferiorly towards the iliac fossa. The fat within the perirenal space is of relevance to radiological investigations since adipose tissue is radiolucent by comparison with renal tissue.

STRUCTURE OF THE KIDNEYS

Section of the renal parenchyma reveals an outer reddish brown cortex and inner paler medulla (Fig. 2). The cortex

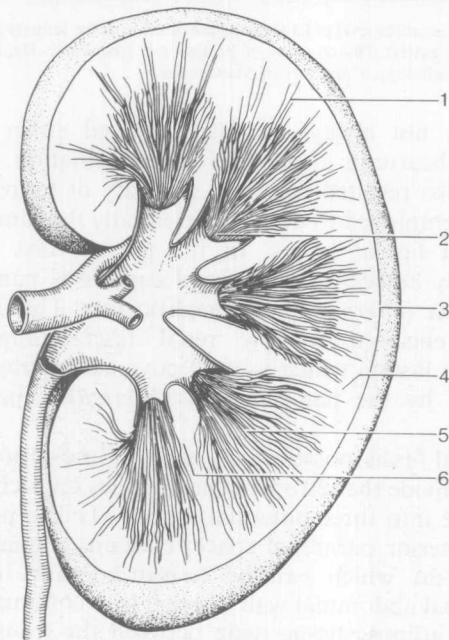


FIG. 2. Diagram of a bisected human kidney showing several renal pyramids, each consisting of cortex and medulla. Numerous medullary rays project towards the renal capsule. 1 = medullary ray; 2 = renal papilla; 3 = renal capsule; 4 = renal cortex; 5 = renal medulla; 6 = column of Bertin.

has a finely granular macroscopic appearance and is limited externally by the renal capsule. The medulla consists of 8–18 conical structures, the renal pyramids each with their base towards the cortex and their apex or papilla projecting into a minor calix. The lateral boundaries of each pyramid are defined by inward extensions of darker cortical tissue which form the renal columns (of Bertin). A renal pyramid together with the cortical tissue overlying its base and covering its sides constitutes a renal lobe. In fetal life the separate lobes are recognizable as distinct convexities on the surface of the kidney, but they usually fuse to form the continuous smooth surface seen in the adult.

From the base of each medullary pyramid a number of thin, radially directed striated elements called medullary rays extend into the cortical substance (Fig. 3). Each medullary ray forms the centre of a small conical-shaped region of renal parenchyma called a lobule.



FIG. 3. Low power photomicrograph of renal parenchyma showing medulla and cortex with medullary rays (R). Part of a minor calix (C) is also visible. ($\times 15$).

The radial striations of each renal pyramid converge towards the apex of the papilla, the striations resulting from the straight portions of the uriniferous tubules and their associated blood vessels. The tip of each papilla (the area cribrosa) is perforated by 10–25 small openings where the uriniferous tubules open into a minor calix.

Regional variation in structure along the length of the tubules gives rise to grossly distinguishable zones within the medulla, namely an outer zone adjacent to the cortex and an inner zone. The outer zone, in turn, may be further subdivided into a darker and thicker inner stripe and a lighter and thinner outer stripe.

Each kidney contains approximately 1.5 million uriniferous tubules which consist of two principal portions. The first, the nephron, is concerned with the formation of urine, and the second, the collecting tubule, serves as an excretory duct which conveys urine to the minor calix. The two components of each tubule arise from separate primordia which interconnect during development. The nephrons develop from the metanephrogenic blastema,

whereas the collecting tubules are derived from the ureteric bud (a diverticulum of the mesonephric duct).

The Nephron

The nephron is the functional unit of the kidney and comprises several morphologically distinct segments (Fig. 4). The proximal blind end of each nephron is a thin-walled

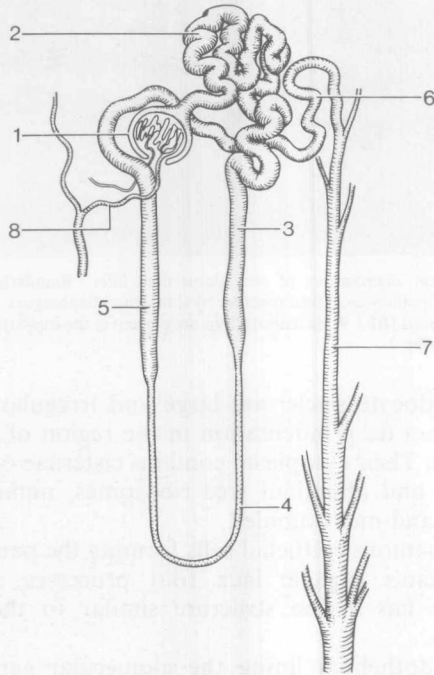


FIG. 4. Diagrammatic representation of a nephron to show its constituent parts, namely Bowman's capsule, proximal convoluted tubule, descending limb, distal convoluted tubule together with a collecting tubule. 1 = Bowman's capsule; 2 = proximal convoluted tubule; 3 = descending limb; 4 = loop of Henle; 5 = ascending limb; 6 = distal convoluted tubule; 7 = collecting duct; 8 = afferent arteriole.

expansion, the Bowman's capsule, which is deeply indented by a tuft of capillaries, the glomerulus (Fig. 5). A glomerulus together with its Bowman's capsule comprises a renal corpuscle. The convoluted parts of the proximal and distal tubules lie in the cortex close to the renal corpuscle. That part of the nephron between the convoluted segments forms a loop (of Henle) which extends from the cortex for a variable distance into the medulla. The loops from nephrons in the outer part of the cortex extend as far as the inner stripe of the outer zone of the medulla; those arising from juxtamedullary nephrons reach the renal papilla.

Renal Corpuscle

Renal corpuscles are located in the renal cortex and are approximately oval in shape with diameters ranging from 150 to 250 μm (Fig. 6). In each renal corpuscle the Bowman's capsule surrounds the tuft of glomerular

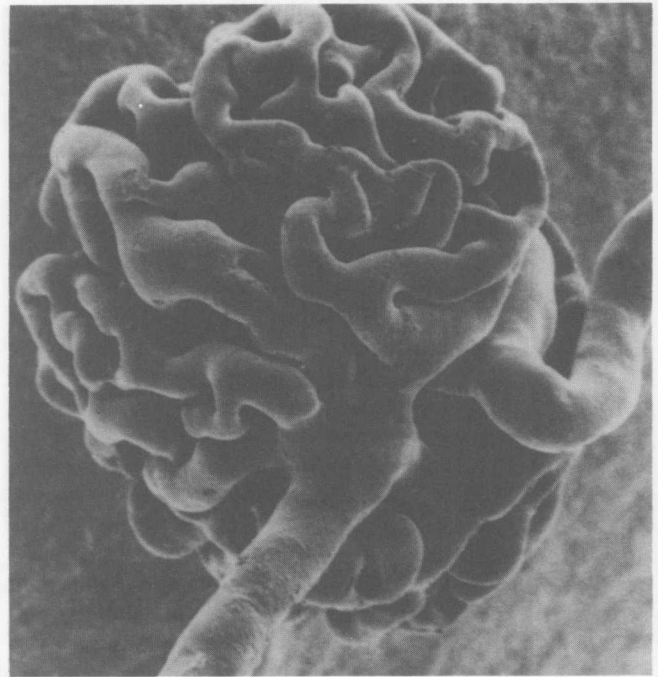


FIG. 5. Scanning electron micrograph of a resin cast of a human renal glomerulus, showing the afferent and efferent arterioles and the branching blood capillaries. This specimen was prepared by injecting resin into the vascular system of the kidney and then dissolving away the surrounding tissue. ($\times 500$)

capillaries as a double-layered cup-shaped structure. The outer wall is the parietal layer and the inner visceral layer closely embraces the glomerulus. The space between the two layers contains glomerular filtrate and is called Bowman's space. Between the epithelium and the capillaries is an extracellular layer of basement membrane (basal lamina). At the vascular pole of the glomerulus, the visceral layer of epithelium is reflected away from the glomerular vessels to become continuous with the parietal layer. At the urinary pole, the capsular epithelium is continuous with the cuboidal epithelium of the proximal convoluted tubule (Fig. 6).

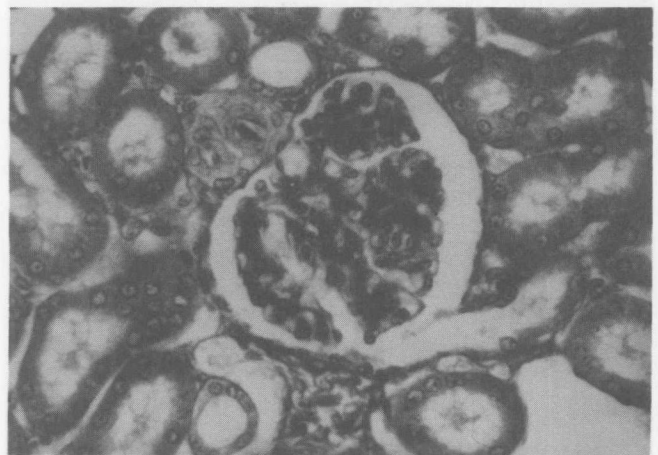


FIG. 6. Renal glomerulus with proximal and distal convoluted tubules. Bowman's capsule is continuous with the proximal convoluted tubule at the urinary pole while at the vascular pole the afferent and efferent arterioles may be seen. ($\times 300$)