



# ADVANCES IN PHYSIOLOGICAL SCIENCES

**Volume 11**

## **Kidney and Body Fluids**

**Editor**

**L. TAKÁCS**

**PERGAMON PRESS**  
**AKADÉMIAI KIADÓ**

# ADVANCES IN PHYSIOLOGICAL SCIENCES

Proceedings of the 28th International Congress of Physiological Sciences  
Budapest 1980

---

Volume 11

## Kidney and Body Fluids

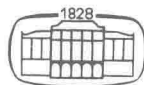
*Editor*

L. Takács

*Budapest, Hungary*



PERGAMON PRESS



AKADÉMIAI KIADÓ

Pergamon Press is the sole distributor for all countries, with the exception of the socialist countries.

HUNGARY	Akadémiai Kiadó, Budapest, Alkotmány u. 21. 1054 Hungary
U.K.	Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England
U.S.A.	Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A.
CANADA	Pergamon of Canada, Suite 104, 150 Consumers Road, Willowdale, Ontario M2J 1P9, Canada
AUSTRALIA	Pergamon Press (Aust.) Pty. Ltd., P.O. Box 544, Potts Point, N.S.W. 2011, Australia
FRANCE	Pergamon Press SARL, 24 rue des Ecoles, 75240 Paris, Cedex 05, France
FEDERAL REPUBLIC OF GERMANY	Pergamon Press GmbH, 6242 Kronberg-Taunus, Hammerweg 6, Federal Republic of Germany

---

Copyright © Akadémiai Kiadó, Budapest 1981

*All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the publishers.*

#### **British Library Cataloguing in Publication Data**

International Congress of Physiological Sciences  
(28th : 1980 : Budapest)  
Advances in physiological sciences  
Vol. 11: Kidney and body fluids  
I. Physiology - Congresses  
I. Title II. Takacs, L.  
591.1 QP1 80-42187

Pergamon Press	ISBN 0 08 026407 7 (Series) ISBN 0 08 026824 2 (Volume)
Akadémiai Kiadó	ISBN 963 05 2691 3 (Series) ISBN 963 05 2737 5 (Volume)

*In order to make this volume available as economically and as rapidly as possible the authors' typescripts have been reproduced in their original forms. This method unfortunately has its typographical limitations but it is hoped that they in no way distract the reader.*

*Printed in Hungary*

ADVANCES IN  
PHYSIOLOGICAL SCIENCES

---

Volume 11

Kidney and Body Fluids

## ADVANCES IN PHYSIOLOGICAL SCIENCES

*Proceedings of the 28th International Congress of Physiological Sciences  
Budapest 1980*

---

### Volumes

- 1 – Regulatory Functions of the CNS. Principles of Motion and Organization
- 2 – Regulatory Functions of the CNS. Subsystems
- 3 – Physiology of Non-excitabile Cells
- 4 – Physiology of Excitable Membranes
- 5 – Molecular and Cellular Aspects of Muscle Function
- 6 – Genetics, Structure and Function of Blood Cells
- 7 – Cardiovascular Physiology. Microcirculation and Capillary Exchange
- 8 – Cardiovascular Physiology. Heart, Peripheral Circulation and Methodology
- 9 – Cardiovascular Physiology. Neural Control Mechanisms
- 10 – Respiration
- 11 – Kidney and Body Fluids
- 12 – Nutrition, Digestion, Metabolism
- 13 – Endocrinology, Neuroendocrinology, Neuropeptides – I
- 14 – Endocrinology, Neuroendocrinology, Neuropeptides – II
- 15 – Reproduction and Development
- 16 – Sensory Functions
- 17 – Brain and Behaviour
- 18 – Environmental Physiology
- 19 – Gravitational Physiology
- 20 – Advances in Animal and Comparative Physiology
- 21 – History of Physiology

### *Satellite symposia of the 28th International Congress of Physiological Sciences*

- 22 – Neurotransmitters in Invertebrates
- 23 – Neurobiology of Invertebrates
- 24 – Mechanism of Muscle Adaptation to Functional Requirements
- 25 – Oxygen Transport to Tissue
- 26 – Homeostasis in Injury and Shock
- 27 – Factors Influencing Adrenergic Mechanisms in the Heart
- 28 – Saliva and Salivation
- 29 – Gastrointestinal Defence Mechanisms
- 30 – Neural Communications and Control
- 31 – Sensory Physiology of Aquatic Lower Vertebrates
- 32 – Contributions to Thermal Physiology
- 33 – Recent Advances of Avian Endocrinology
- 34 – Mathematical and Computational Methods in Physiology
- 35 – Hormones, Lipoproteins and Atherosclerosis
- 36 – Cellular Analogues of Conditioning and Neural Plasticity

*(Each volume is available separately.)*

## FOREWORD

This volume is one of the series published by Akadémiai Kiadó, the Publishing House of the Hungarian Academy of Sciences in coedition with Pergamon Press, containing the proceedings of the symposia of the 28th International Congress of Physiology held in Budapest between 13 and 19 July, 1980. In view of the diversity of the material and the "taxonomic" difficulties encountered whenever an attempt is made to put the various subdisciplines and major themes of modern physiology into the semblance of some systematic order, the organizers of the Congress had to settle for 14 sections and for 127 symposia, with a considerable number of free communications presented either orally or as posters.

The Congress could boast of an unusually bright galaxy of top names among the invited lecturers and participants and, naturally, the ideal would have been to include all the invited lectures and symposia papers into the volumes. We are most grateful for all the material received and truly regret that a fraction of the manuscripts were not submitted in time. We were forced to set rigid deadlines, and top priority was given to speedy publication even at the price of sacrifices and compromises. It will be for the readers to judge whether or not such an editorial policy is justifiable, for we strongly believe that the value of congress proceedings declines proportionally with the gap between the time of the meeting and the date of publication. For the same reason, instead of giving exact transcriptions of the discussions, we had to rely on the introductions of the Symposia Chairmen who knew the material beforehand and on their concluding remarks summing up the highlights of the discussions.

Evidently, such publications cannot and should not be compared with papers that have gone through the ordinary scrupulous editorial process of the international periodicals with their strict reviewing policy and high rejection rates or suggestions for major changes. However, it may be refreshing to read these more spontaneous presentations written without having to watch the "shibboleths" of the scientific establishment.

September 1, 1980

J. Szentágothai

President of the  
Hungarian Academy of Sciences

# INTRODUCTION

This volume intends to summarize scientific material of Invited Lectures and Symposia of Section 06 "Kidney and Body Fluids" of the 28th International Congress of Physiological Sciences held in Budapest, July 13–19, 1980.

Selection of Invited Lecturers, topics and Invited Speakers of Symposia preceded the Congress by about one and a half years and arrangements were made after having consulted with the IUPS Council, and having considered the opinions of prominent nephrologists and, finally, according to the viewpoints of the local Section Organizing Committee. Chairmen of Symposia were invited with similar circumspection who, thereafter, suggested persons to be Invited Speakers of Symposia after careful multilateral exchange of ideas. Accordingly, we organized the Programme of the Section and compiled this Volume with the hope of giving a material representing promising research trends. May we hope that participants of the Congress and readers of this book will meet with their expectations.

The Symposia were organized by a uniform schedule: chairmen's introduction was usually followed by four Invited Papers and complemented by five Free Communications. This procedure rendered possible completion of selection on the basis of invitation as well as correction of errors in organization. Chairmen were asked to give a brief summary of main results and discussions.

Actually, this Volume comprises 80 papers of 93 presented. To our sincere regret, a part of the papers lacking could not be submitted because of copyright difficulties while others have not reached us for unknown reasons. In the latter cases the Abstract Volume will be helpful for general survey of the Section's Programme.

Finally, we would like to apologize for possible faults and errors in preparing this Volume, but our primary aim and intention was – similarly to all other volumes in this Series – to make it available in a published form as soon as possible.

Lajos Takács  
editor

# CONTENTS

Foreword .....	v
Introduction	
L. TAKÁCS .....	xv
Neural control of renal function	
C. W. GOTTSCHALK, R. E. COLINDRES, N. G. MOSS, P. R. ROGENES and L. SZALAY .....	1
A membrane-molecular approach to renal physiology	
R. KINNE .....	19
Phylogenetic aspects of ion transport in the kidney	
Y. V. NATOCHIN .....	35
Renal cortical interstitium and renal lymph with remarks on a stochastic concep- tion of the reflexion coefficient of the peritubular capillary wall	
G. G. PINTER and P. D. WILSON .....	57
Tubulo-glomerular feedback	
K. THURAU .....	75
 <b>Ontogenetic aspects, compensatory hypertrophy</b>	
Renal ontogeny and compensatory hypertrophy	
M. BERGERON and G. THIÉRY .....	85
Ontogeny of amino acid reabsorption in mammalian kidney, the proline model	
C. R. SCRIVER, M. BERGERON and M.-F. ARTHUS .....	97
Para-amino-hippurate uptake by cultured fetal mouse kidneys	
J. DIEZI, M. NENNIGER and P. MICHOD .....	107
The developing kidney and the age-dependent adaptation to the salt intake	
H. DLOUHÁ, J. KŘEČEK and J. ZICHA .....	111
Factors influencing renal sodium excretion in the fetal lamb	
A. D. STEVENS and E. R. LUMBERS .....	119



Development of glomerular and tubular function in fetal and newborn pigs and their response to hypotonic saline load J. M. ALT, B. COLENBRANDER and A. A. MACDONALD	125
Structural and functional compensatory hypertrophy in chronically altered rat nephrons R. A. KRAMP and W. B. LORENZ	131
Kidney collagen content following nephrectomy in rats of different ages N. S. AL-ZAID and M. J. McBROOM	135
The role of lymphatic tissue in the compensatory renal growth B. RADOŠEVIĆ-STAŠIĆ, M. CUK and D. RUKAVINA	141
Integration of water and salt metabolism control mechanisms in ontogenesis L. K. VELIKANOVA and R. I. AIZMAN	147
Concluding remarks on renal ontogeny and hypertrophy M. BERGERON and H. DLOUHÁ	153

### Renal cell cultures

Renal cell cultures M. CEREIJIDO and I. MEZA	157
Hormone-dependent differential growth of renal epithelia cultivated in vitro from individual mammalian nephron segments M. F. HORSTER	169
Transport related properties and the development of polarity of an established epithelial cell line of renal origin J. M. MULLIN, J. WEIBEL, L. DIAMOND and A. KLEINZELLER	175
Concluding remarks on renal cell cultures M. CEREIJIDO and M. HORSTER	181

### Renal blood flow

Introduction to renal blood flow L. HÁRSING	185
"Redistribution" of intrarenal blood flow: a question of microsphere size? K. AUKLAND	191
General and intrarenal hemodynamic alterations after unilateral nephrectomy in rats J. M. LÓPEZ-NOVOA, B. RAMOS, J. E. MARTÍN-OAR and L. HERNANDO	199

Macula densa feedback regulation of renal hemodynamics and renal autoregulation	
L. G. NAVAR, P. D. BELL and P. L. ADAMS	205
Autoregulation of glomerular filtration rate and renal blood flow in conscious rats	
M. GELLAI and H. VALTIN	217
Role of calcium and albumin in the autoregulation of renal blood flow	
J. C. S. FRAY, S. BAKER jr., N. J. LAURENS and A. J. COHEN	223
Renal and nephron hemodynamics in the dog kidney at varying perfusion pressure	
J. HELLER	229
Renal vascular tone affects the severity of renal artery stenosis in conscious dogs	
W. P. ANDERSON and P. I. KORNER	239
Effect of indomethacin (IM) on renal function before and after release of 24 hours unilateral (UUL) and bilateral (BUL) ureteral ligation	
P. BÁLINT and K. LÁSZLÓ	245
Concluding remarks on renal blood flow	
L. HÁRSING	255

### Glomerulotubular balance

Glomerulotubular balance	
F. KIIL	261
Intraluminal control of glomerulotubular balance (GTB)	
E. BARTOLI	269
Intrinsic factors regulating glomerulotubular balance	
J. P. KOKKO	279
Carbonic anhydrase and Na, K-ATPase in the regulation of tubular sodium transport	
Ø. M. SEJERSTED, Ø. MATHISEN, T. MONCLAIR, H. HOLDAAS, P. A. STEEN and F. KIIL	289
The relationship between glomerular tubular balance (GTB) and the hydrodynamics in the mammalian proximal tubule	
H. v. BAEYER, D. A. HAEBERLE and H. BAUER	299
Glomerulotubular balance: renal bicarbonate reabsorption varies with plasma pH	
H. LANGBERG, Ø. MATHISEN, H. HOLDAAS and F. KIIL	305

Bicarbonate as mediator of glomerulotubular balance during osmotic diuresis Ø. MATHISEN, M. RAEDER and F. KIIL .....	309
Concluding remarks on glomerulotubular balance F. KIIL .....	313

### Cell ionic activity and element analysis

Element-specific biophysical approaches to the study of intracellular fluids M. M. CIVAN .....	319
Intracellular electrochemical potentials of $K^+$ , $Na^+$ , $Cl^-$ and $HCO_3^-$ in cells of renal tubules R. N. KHURI .....	327
Direct measurement of intracellular Na and K activities in the renal tubular cells with triple-barreled micro-electrodes M. FUJIMOTO and M. HONDA .....	341
Membrane potentials and elemental microanalysis of renal papillary cells R. BEEUWKES, R. BULGER, L. TERESI, J. SANDS and A. SAUBERMANN .....	351
Cytosolic Ca ion activity in proximal tubular cells of Necturus kidney C. O. LEE, A. TAYLOR and E. E. WINDHAGER .....	357
Concluding remarks on cell ionic activity and element analysis M. M. CIVAN and M. FUJIMOTO .....	363

### Electrophysiology and epithelial transport

Introduction to electrophysiology and epithelial transport: The use of fast concentration step experiments in the electrical analysis of tubular transport E. FRÖMTER .....	367
Time course of ouabain and furosemide effects on transepithelial potential difference in cortical thick ascending limbs of rabbit nephrons R. GREGER and E. FRÖMTER .....	375
Inhibition of fluid reabsorption and sodium efflux by low peritubular Na and by A23187 or quinidine in isolated perfused proximal tubules of the rabbit J. F. FIGUEIREDO, P. A. FRIEDMAN, T. MAACK and E. E. WINDHAGER .....	381
The double-barreled microelectrode for the measurement of intracellular pH, using liquid ion-exchanger, and its biological application Y. MATSUMURA, S. AOKI, K. KAJINO and M. FUJIMOTO .....	387

Electrical properties of proximal tubular cell membranes of <i>Necturus</i> kidney T. ANAGNOSTOPOULOS	393
Changes in membrane resistance of renal proximal tubule induced by cotransport of sodium and organic solute T. HOSHI, K. KAWAHARA, R. YOKOYAMA and K. SUENAGA	403
A cyanine dye as indicator of membrane electrical potential differences in brush border membrane vesicles. Studies with $K^+$ gradients and $Na^+$ /amino acid cotransport G. BURCKHARDT and H. MURER	409
The stoichiometry of $Na^+$ coupled anion absorption across the brushborder membrane of rat renal proximal tubule I. SAMARZIJA, V. MOLNAR and E. FRÖMTER	419
Concluding remarks on electrophysiology and epithelial transport E. FRÖMTER and T. ANAGNOSTOPOULOS	425

### Tubular handling of calcium and phosphate

Mechanisms of renal epithelial transport of phosphate V. W. DENNIS and P. C. BRAZY	429
Effect of pH on renal phosphate transport K. J. ULLRICH, G. BURCKHARDT, H. STERN and H. MURER	435
Control of the tubular handling of phosphate: relation between the adaptation mechanism and 1,25-dihydroxyvitamin $D_3$ J.-P. BONJOUR, J. CAVERZASIO, H. FLEISCH, R. MÜHLBAUER and U. TRÖHLER	449
Adaptation of tubular phosphate ( $P_i$ ) transport to renal mass reduction in thyroparathyroidectomized (TPTX) rats J. CAVERZASIO, H. J. GLOOR, H. FLEISCH and J.-P. BONJOUR	453
Renal handling of phosphate ( $P_i$ ) and calcium ( $Ca$ ) in X-linked hypophosphatemic (HYP) mice R. C. MÜHLBAUER, J.-P. BONJOUR and H. FLEISCH	455
Heterogeneity of calcium transport in the medullary and cortical segments of the thick ascending limb W. N. SUKI and D. ROUSE	457
Concluding remarks on tubular handling of calcium and phosphate W. N. SUKI	461

### Tubular acidification

$H^+$ electrochemical potential profile and luminal acidification in <i>Necturus</i> proximal tubule M. G. O'REGAN	465
---	-----

Role of anion transport mechanisms in proximal tubule acidification D. G. WARNOCK and V. J. YEE .....	471
Proton translocation systems in rat renal brush border membranes E. KINNE-SAFFRAN, R. BEAUWENS, R. KINNE and H. MURER .....	481
Primary electrogenic H pump in the proximal tubule M. BICHARA and M. PAILLARD .....	489
Profile of total CO <sub>2</sub> movements along the proximal tubule of rat kidney B. CORMAN, R. THOMAS, R. McLEOD and C. de ROUFFIGNAC .....	495
Studies on the disequilibrium pH in renal tubules G. MALNIC and M. de MELLO AIRES .....	499
Renal tubular net acid (NA) excretion: interpretations from potassium imbalance B. KARLMARK, Ph. JAEGER and G. GIEBISCH .....	507
Reabsorptive mechanism of bicarbonate ions across the luminal membrane of proximal tubule K. KAJINO, Y. MATSUMURA, T. KUBOTA, K. KOTERA and M. FUJIMOTO ...	513
Concluding remarks on renal tubular acidification G. GIEBISCH and G. MALNIC .....	519

### Regulation of water balance

Nonosmotic release and vascular effects of vasopressin R. W. SCHREIER, W. A. HANDELMAN, J. P. GOLDBERG, D. SCHREIER, G. AISENBREY, M. MANNING and T. BERL .....	525
Osmotic and hemodynamic control of vasopressin: functional and anatomical relationships G. L. ROBERTSON .....	537
The effect of vasopressin on its target cell R. M. HAYS .....	547
The role of angiotensin II in the control of hypovolaemic thirst and sodium appetite J. T. FITZSIMONS .....	555
Effect of osmotic stimuli on the concentration of vasopressin in jugular and peripheral venous plasma P. BIE, C. WADE, L. C. KEIL and D. J. RAMSAY .....	563
Role of arginine vasotocin (AVT) in osmoregulation of conscious pekin ducks at different states of salt and water balance: central and afferent control of serum AVT C. SIMON-OPPERMANN, J. MÖHRING, J. SCHOUN and E. SIMON .....	569

Concentration of urine in the absence of vasopressin: effect of decreased renal perfusion pressure in conscious Brattleboro homozygotes	
H. VALTIN, M. GELLAI and B. R. EDWARDS	575
A circulating plasma factor that inhibits the action of antidiuretic hormone	
T. MORGAN, C. RAY and S. CARNEY	581
Mechanism of the renal hyaluronate-hydrolase activation in response to ADH	
L. N. IVANOVA and T. E. GORYUNOVA	587

### Extracellular volume control

Introductory remarks to the control of the extracellular fluid volume	
F. S. NASHAT	595
Role of sodium in cerebral control of body fluid homeostasis	
B. ANDERSSON, L. G. LEKSELL and K. OLSSON	601
Postprandial volume regulation and renin-angiotensin system in conscious dogs	
G. KACZMARCZYK, M. ECHT, R. MOHNHAUPT, B. SIMGEN and H. W. REINHARDT	611
The renal response to salt loading	
C. S. WILCOX	621
The past and the presence of a natriuretic hormone	
B. LICHARDUS and J. PONEC	631
Cerebral sodium sensors, thirst and sodium balance in sheep	
M. J. MCKINLEY, P. CONSIDINE, D. A. DENTON, L. G. LEKSELL, E. TARJAN and R. S. WEISINGER	637
Diuretic response to left atrial distension is eliminated after cardiac denervation	
K. L. GOETZ, D. C. FATER, H. D. SCHULTZ and W. D. SUNDET	643
Food restriction, fluid balance and electrolyte balance in sheep	
A. R. MICHELL	649
Extracellular fluid volume in skeletal muscle of man as affected by postural changes	
G. SJØGAARD and F. BONDE-PETERSEN	655
The nature and the mechanism of the liver osmoreceptor excitation	
E. M. TYRYSHKINA	659
Concluding remarks on control of the extracellular fluid volume	
F. S. NASHAT and G. KACZMARCZYK	665
Index	667

## NEURAL CONTROL OF RENAL FUNCTION\*

Carl W. Gottschalk\*\*, Romulo E. Colindres, Nicholas G. Moss,  
Paula R. Rogenes and Laszlo Szalay\*\*\*

*Departments of Medicine and Physiology University of North Carolina School of Medicine, Chapel Hill,  
North Carolina, USA*

This morning I wish to consider the role of the renal nerves in maintaining the homeostasis of the body fluids. I will discuss the efferent control of excretory activity and the nature of the renal receptors that send afferent impulses to the neural axis when stimulated. I will also consider the possibility of a neural mechanism, a renorenal reflex, being responsible for the coordination of the excretory activity of the two kidneys that occurs when the function of one of the kidneys is altered.

Claude Bernard (1859) was the first to report that acute section of the splanchnic nerves in an anesthetized dog results in an increase in urine production by the ipsilateral kidney. This observation has been repeatedly confirmed over the subsequent years. The two problems addressed by most investigators have been, (first) whether the effect is exclusively hemodynamic in origin due to an increase in glomerular filtration rate and renal blood flow, or whether there is also an effect on the tubular mechanisms for reabsorption, and secondly, whether the effect, whatever its mechanism, is evident only under the abnormal circumstances of anesthesia and surgery, and thus should not be considered a response to "physiological" alterations. Until recently the answer to the first question was that the effect was exclusively hemodynamic, but I will review the compelling evidence that the sympathetic efferent inflow to the kidney has a direct effect on tubular reabsorptive mechanisms which may under certain circumstances

\*Supported by National Institutes of Health Grants HL02334 and NS1132 and by a Grant-in-Aid from the American Heart Association

\*\*Career Investigator, American Heart Association

\*\*\*Career Investigator Fellow, American Heart Association

be magnified by hemodynamic factors, although the latter need not occur. I do not believe that the answer to the second question has yet been completely resolved. Almost all of the published evidence favors the view that it is apparent only when the animal is severely stressed. More recent studies, however, indicate that the effects of denervation may be seen in conscious animals.

The neural efferent mechanism for control of salt and water excretion has been intensively investigated in recent years in 3 laboratories, by Dr. Takacs and his colleagues at Semmelweis University here in Budapest, by Dr. DiBona and colleagues at the University of Iowa, and by my associates in the Chapel Hill Micropuncture Laboratory. The results obtained in these laboratories have been complementary.

The recent description of a tubular innervation provides an anatomical basis for the tubular functional effects reported by these 3 laboratories. It has been known since the studies of Bradford (1889) that there is a rich sympathetic innervation of the blood vessels of the kidney; although there have been periodic reports of a direct tubular innervation there have been at least as many reports denying this. In the early 1970's Barajas and Mueller presented for the first time convincing evidence for a direct innervation of the tubular cells in the cortex of monkey and rat kidneys (Barajas and Mueller 1973 and Mueller and Barajas 1972). Using electron microscopic and histochemical methods these investigators demonstrated adrenergic nerve terminals separated from proximal and distal tubular cells only by basement membrane material. This relationship is identical to that observed between similar vesiculated varicosities and vascular smooth muscle, a site where synaptic transmission is thought to occur.

#### MICROPUNCTURE AND CLEARANCE EXPERIMENTS

Although a proximal tubular effect was first reported by Bencsath et al. (1972), the Chapel Hill group was the first to provide extensive micropuncture documentation for such a result. Bello-Reuss et al. (1975) characterized the renal response to acute unilateral denervation in an extensive study of sham denervated and denervated kidneys. Denervation of a kidney was accomplished by stripping the renal artery of its adventitia and coating it with a solution of 10% phenol in alcohol. For a variety of reasons the functional changes observed cannot be attributed to a direct effect of phenol on kidney function: no norepinephrine could be detected in the kidneys several days after denervation; incomplete denervation from splanchnic nerve crushing produced similar, but quantitatively smaller results than the apparently complete chemical denervation, and these effects were reversed by electrical stimulation of the distal end of the cut splanchnic nerve. Coating the artery with lidocaine instead of phenol produced similar but transitory effects.



No changes were observed in any function of either kidney of sham-denervated rats. Following unilateral denervation in hydropenic animals urine volume from the denervated kidney increased to about twice its control value, and urinary sodium excretion increased sixfold. There was no change in urine volume or sodium excretion from the innervated kidney. Glomerular filtration rate (GFR) and renal plasma flow (RPF) remained unchanged in both kidneys after the procedure. SNGFR remained unchanged after denervation. The fluid-to-plasma ratio of inulin decreased in samples of fluid collected from late proximal tubules of denervated kidneys indicating a 60% decrease in water and sodium reabsorption by the proximal tubule. Absolute water and sodium reabsorption increased in the loop of Henle, distal convolution, and collecting ducts, but not enough to compensate for the 60% decrease in the proximal tubule.

Denervation caused no change in estimated glomerular capillary or efferent arteriolar pressure. There were very small increases in hydrostatic pressure in proximal and distal convolutions and in small peritubular capillaries. Since there was no change in whole kidney or single nephron GFR and renal plasma flow was unchanged, it is unlikely that there was a change in overall or superficial nephron colloid osmotic pressure or significant redistribution of renal blood flow. It thus appears that the physical factors did not play an important role in the observed changes in tubular reabsorption.

Similar results were observed in animals expanded 10% above their body weight by an infusion of isotonic saline solution (Bello-Reuss et al. 1977). There was no change in GFR or RPF in either kidney after unilateral denervation or sham denervation. Urine flow and sodium excretion by denervated kidneys was doubled. Simultaneously urine flow and sodium excretion by the contralateral innervated kidneys fell by half so that there was little change in total salt and water excretion. I will return to this striking finding shortly. After denervation SNGFR remained unchanged. The F/P inulin ratio in fluid from late proximal tubules decreased, indicating a fall in water and sodium reabsorption in the proximal tubule of more than 50%. Absolute water and sodium reabsorption increased after denervation in the loop of Henle, distal convolution and collecting ducts but not enough to prevent the natriuresis and diuresis.

In another series of experiments in anesthetized rats the natriuresis and diuresis resulting from unilateral crushing of the greater splanchnic nerve was reversed by electrical stimulation of the distal portion of the cut nerve with square wave pulses of 0.5 msec duration, voltage twice threshold, and 1 or 2 Hz frequency (Bello-Reuss et al. 1976). Kidney GFR and RPF and SNGFR remained unchanged during stimulation. Nerve stimulation produced a reduction of approximately 25% in urine flow and sodium excretion due to increased water reabsorption in the proximal tubule. In 5 of 6 animals, stimulation at 1