



# ADVANCES IN PHYSIOLOGICAL SCIENCES

**Volume 12**

## **Nutrition, Digestion, Metabolism**

**Editors**

**T. GÁTI**

**L. G. SZOLLÁR**

**Gy. UNGVÁRY**

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

# ADVANCES IN PHYSIOLOGICAL SCIENCES

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

---

Volume 12

## Nutrition, Digestion, Metabolism

*Editors*

T. Gáti  
L. G. Szollár  
Gy. Ungváry  
*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. 12: Nutrition, digestion, metabolism

1. Physiology - Congresses

I. Title      II. Gáti, T.      III. Szollár, L. G.

IV. Ungváry, Gy.

591.1      QP1      80-42185

Pergamon Press      ISBN 0 08 026407 7 (Series)  
ISBN 0 08 026825 0 (Volume)

Akadémiai Kiadó      ISBN 963 05 2691 3 (Series)  
ISBN 963 05 2738 3 (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 12

Nutrition, Digestion, Metabolism

## 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

## PREFACE

The 28th Congress of Physiological Sciences was held in Budapest amid a greater interest than ever on previous similar occasions.

In the Nutrition-Digestion-Metabolism section alone 268 papers were presented including two invited lectures.

In the frames of nine symposiums 58 invited and 30 free presentations were delivered. In the free communication part 69 oral communications and 109 posters were presented.

From all this material this volume contains the two invited lectures and the subject matter of the following eight symposiums:

- I. Vitamins and trace elements
- II. Role of cyclic nucleotides in stimulus—secretion coupling of exocrine glands
- III. Physiological components of the gastric mucosal barrier and their role in mucosal defense
- IV. Motility in control of gastric emptying
- V. Intestinal polypeptides and peptidergic nerves
- VI. Molecular changes during metabolic processes of gastrointestinal peptide hormones
- VII. Factors involved in the integrated mechanism of intestinal absorption
- VIII. Lipoprotein metabolism, apolipoproteins, lipid constituents

The Lecture Halls were filled to capacity. In general there was a lively discussion and a useful exchange of experiences after the lectures.

The presentations of the Poster Section were also followed with great interest. Unfortunately — because of technical reasons — we are not able to publish them.

We would like to thank to all the authors of the manuscripts, especially to Prof. Bonfils and Prof. Ugolev invited lecturers as well as to Prof. R. Buzina, Prof. J. Christophe, Prof. K. J. Öbrink, Prof. E. E. Daniel, Prof. B. Uvnäs, Prof. V. Varró, Prof. T. Z. Csaky, and Prof. P. S. Roheim; furthermore to Dr. E. Morava, Dr. Gy. Mózsik, Prof. E. Atanassova, Dr. J. Szolcsányi, Dr. L. Varga, Dr. T. Várkonyi and Dr. L. G. Szollár for the excellent organization of the symposia.

We also thank to Professors J. A. Young and R. M. Case for organizing the 9th Symposium titled: "Mechanism of Gastrointestinal Exocrine Secretion" the material of which will appear elsewhere.

We would like to express our gratitude to the Publishing House of the Hungarian Academy of Sciences for its valuable work.

Budapest, October 1980

Prof. T. Gáti  
Chairman of the Nutrition-  
Digestion-Metabolism section



# CONTENTS

Foreword .....	v
Preface .....	xv
Hormonal receptors in the cell regulation of digestive functions S. BONFILS .....	1
Revised concept of functional and structural organization of the enzyme- transport systems of the apical membrane of the enterocytes A. M. UGOLEV .....	9
 <b>Vitamins and trace elements</b>	
Introduction to vitamins and trace elements R. BUZINA .....	27
Dietary vitamin D, sunlight and the cause of rickets D. E. M. LAWSON .....	35
Phosphate influx across the mucosal border of rabbit small intestine. Effect of 1,25- dihydroxycholecalciferol G. DANISI, J-Ph. BONJOUR and R. W. STRAUB .....	43
Interactions between magnesium and 1.25 dihydroxycholecalciferol in uremic rats H. SCHIFFL, M. HUGGLER, C. BECKER and U. BINSWANGER .....	49
Effects of mild and severe renal insufficiency on the calcium transport of the rat ileum in vitro M. KOLLER and U. BINSWANGER .....	55
Some effects of cadmium on calcium metabolism in rats E. MORAVA and A. GERGELY .....	61
Zinc and cadmium metalloprotein induced by cadmium administration S. BONDIA, B. RIBAS, A. De la TORRE and A. SANTOS RUIZ .....	71
Some kinetic aspects of ascorbic acid in man A. KALLNER, D. HARTMANN and D. HORNIG .....	77

The role of ascorbic acid in lipid metabolism and atherogenesis E. GINTER, P. BOBEK, J. BABALA, F. KUBEC, D. URBANOVÁ and O. ČERNÁ	79
Influence of riboflavin deficiency on intestinal drug metabolizing enzyme activities in rat E. HIETANEN, U. KOIVUSAARI and A. NORLING	89
Influence of protein, iron and copper level in the diet on dynamics of digestion in duodenum S. IWAŃSKA, B. TYSZKO and D. STRUSIŃSKA	95
The interaction between chromium and insulin W. MERTZ	101
Concluding remarks on vitamins and trace elements R. BUZINA and E. MORAVA	107

### Role of cyclic nucleotides in stimulus—secretion coupling of exocrine glands

Origin and possible role of cyclic GMP and cyclic AMP in rat and guinea pig pancreatic acinar cells J. CHRISTOPHE, M. DESCHODT-LANCKMAN, P. ROBBERECHT, M. SVOBODA, M.-C. VANDERMEERS-PIRET and A. VANDERMEERS	111
Electrophysiological studies on the role of cyclic GMP in pancreatic acinar cell stimulus—secretion coupling O. H. PETERSEN, H. G. PHILPOTT, G. T. PEARSON and J. S. DAVISON	123
Stimulus—secretion coupling in perfused immobilized acini from rat pancreas E. K. FRANDSEN	131
The possible role of cyclic AMP as a second messenger in pancreatic duct cells U. R. FÖLSCH	141
cAMP and secretagogue interactions in isolated gastric glands C. S. CHEW and S. J. HERSEY	149
Feed-back mechanism systems between the ATP—adenylate cyclase—cAMP and ATP—Na <sup>+</sup> —K <sup>+</sup> -dependent ATP-ase—ADP in the rat and human gastric fundic mucosa in relation to gastric acid secretion Gy. MÓZSIK, L. NAGY and F. TÁRNOK	157
Peptidergic regulation of the cyclic AMP system in the intestinal epithelium M. LABURTHE, B. AMIRANOFF and G. ROSSELIN	175

Interaction of secretagogues, bile acids and laxatives with enzymes of cyclic AMP metabolism from human intestinal mucosa	
B. SIMON, H. KATHER and B. KOMMERELL	179
Stimulatory pathways in the regulation of gastric acid secretion	
I. SZELENYI	185
Concluding remarks on role of cyclic nucleotides in stimulus—secretion coupling of exocrine glands	
J. P. CHRISTOPHE and Gy. MÓZSIK	195
<b>Physiological components of the gastric mucosal barrier and their role in mucosal defense</b>	
Introduction to the physiological components of the gastric mucosal barrier and their role in mucosal defense	
T. GÁTI	199
Gastric mucosal bicarbonate production	
G. FLEMSTRÖM	203
Alkaline secretion by the canine Heidenhain pouch in response to exogenous acid, some gastrointestinal hormones and prostaglandin	
A. GARNER and B. C. HURST	215
Effect of gastric mucosal barrier breakers on canine alkaline secretion and transmucosal potential difference	
J. S. ŚWIERCZEK and S. J. KONTUREK	221
The structure and properties of gastric mucus	
A. ALLEN, A. BELL, M. MANTLE, J. P. PEARSON, C. W. VENABLES and F. YOUNAN	227
Secretin stimulation of gastric mucus secretion in the cat: The viscosity of gastric juice in relation to glycoprotein structure and concentration	
B. H. HIRST, R. KAURA and A. ALLEN	237
Loss of hydrogen ions in different parts of the non-stimulated stomach	
K. J. ÖBRINK and M. WALLER	243
The effect of drugs affecting adrenergic mechanism on the gastric transmucosal potential difference in rats	
T. GÁTI, D. SZOMBATH and S. DUBECZ	249
Sources of the positive potential difference across the in vitro frog stomach in Cl-free media	
M. SCHWARTZ, G. CARRASQUER and W. S. REHM	259

Effects of ouabain on in vitro frog stomach G. CARRASQUER, M. SCHWARTZ, T. L. HOLLOMAN and W. S. REHM . . . . .	267
Ca <sup>++</sup> controlled gastric H <sup>+</sup> /K <sup>+</sup> pump: Site of SCN <sup>-</sup> action F. MICHELANGELI and F. PROVERBIO . . . . .	273
Concluding remarks on the physiological components of the gastric mucosal barrier and their role in mucosal defense T. GÁTI . . . . .	279

### Motility in control of gastric emptying

Introduction to motility in control of gastric emptying E. E. DANIEL . . . . .	285
Control of the myoelectric complex of the stomach and small intestines by the intrinsic nervous system E. ATANASSOVA . . . . .	287
Electric activity of forestomach smooth muscles in sheep after infusion of ammonium chloride and alpha and beta adrenergic receptors blockade G. PIERZYŃSKI, P. PODGURNIAK and B. WILCZYŃSKA . . . . .	299
Microelectrode studies on single smooth muscle cells of the fundus before and after functional loading O. BAYGUINOV and E. ATANASSOVA . . . . .	305

### Intestinal polypeptides and peptidergic nerves

Introduction to intestinal polypeptides and peptidergic nerves B. UVNÄS . . . . .	315
Intestinal polypeptides and peptidergic nerves B. UVNÄS . . . . .	317
Cholecystokinin octapeptide: Putative neurotransmitter in the gut G. J. DOCKRAY, J. B. HUTCHISON, R. A. GREGORY, H. J. TRACY and WEN-YU ZHU . . . . .	321
Role of opiate peptides in the regulation of gastrointestinal motility and secretion S. J. KONTUREK . . . . .	329
Enterogastrone candidates among the gastrointestinal polypeptides S. ROSELL . . . . .	341

Effect of intraluminal pH on the release of gastrin and somatostatin from the antropyloric region. The possible role of somatostatin as an inhibitory hormone of gastric acid secretion	
K. UVNÄS-WALLENSTEN	347
Capsaicin-sensitive innervation of the intestine	
L. BARTHÓ and J. SZOLCSÁNYI	355
Effects of amino acids and disaccharides on afferent nerve discharge from rat small intestine in vivo	
J. HARDCASTLE, P. T. HARDCASTLE and P. A. SANFORD	361
Concluding remarks on intestinal polypeptides and peptidergic nerves	
B. UVNÄS	367

### Molecular changes during metabolic processes of gastrointestinal peptide hormones

Introduction to molecular changes during metabolic processes of gastrointestinal peptide hormones	
V. VARRÓ	371
The role of cyclic nucleotides in pancreatic bicarbonate secretion stimulated by secretin and VIP	
W. DOMSCHKE, S. J. KONTUREK and S. DOMSCHKE	373
Molecular conformation influence on transport processes and receptor binding of gastrin; a new scheme of gastric secretory regulation	
P. K. KLIMOV, M. V. POLOSATOV, I. A. SOLOVJEVA and G. M. BARASHKOVA	379
Metabolism of different molecular forms of cholecystokinin	
J. LONOVICS, F. HAJNAL, R. L. SUDDITH, P. L. RAYFORD and J. C. THOMPSON	383
Catabolic pathways of the C-terminal pentapeptide of gastrin (pentagastrin)	
L. VARGA	391
Nervous regulation of the hormone secretion	
A. SVATOS	401
Concluding remarks on molecular changes during metabolic processes of gastrointestinal peptide hormones	
V. VARRÓ	407

### Factors involved in the integrated mechanism of intestinal absorption

Introduction to factors involved in the integrated mechanism of intestinal absorption	
T. Z. CSAKY	411

Intestinal absorption studied by vascular perfusion C. A. R. BOYD .....	413
Significance of the countercurrent mechanism in intestinal absorption M. JODAL and O. LUNDGREN .....	419
Endocrine influence on absorption V. VARRÓ .....	429
Intestinal absorption in man A. M. DAWSON .....	441
The influence of surgical and chemical inhibition of digestive enzymes on the absorption of foreign protein in rats G. ENDERS, J. SEIFERT, K. LEU and W. BRENDDEL .....	447
Vitamin B-12 absorption in gnotobiotic dogs and cecectomized gnotobiotic rats J. B. HENEGHAN and M. Y. MITTELBRONN .....	453
Mechanisms involved in small intestinal transport of calcium and phosphate ions: Studies with isolated plasma membrane vesicles B. HILDMANN, C. STORELLI, A. SCHMIDT and H. MURER .....	459
The role played by the stomach in the rate of glucose absorption in the rat D. J. KEEGAN .....	465
Carrier-mediated uptake of sugars through the basolateral membrane of colon epithelium E. SCHARRER and B. AMANN .....	469
Plasma lipid curves after long and medium chain triglyceride absorption on patients with decreased pancreas lipase activity I. SZLAMKA, E. VAJNA and I. TÁNCZOS .....	475
Concluding remarks on factors involved in the integrated mechanism of intestinal absorption T. Z. CSAKY .....	483

### **Lipoprotein metabolism, apolipoproteins, lipid constituents**

Introduction to lipoprotein metabolism, apolipoproteins, lipid constituents P. S. ROHEIM .....	487
Lipoproteins of biological fluids P. S. ROHEIM, Ch. H. SLOOP and G. L. VEGA .....	489

Regulation of lipoprotein synthesis in cultured hepatocytes	
R. A. DAVIS	497
Chylomicron metabolism	
P. H. E. GROOT, L. M. SCHEEK, G. M. DALLINGA-THIE, A. Van TOL and T. J. C. Van BERKEL	505
Cell receptor and antibody binding domains of apolipoprotein B are not identical	
G. SCHONFELD, W. PATSCH, B. PFLEGER and M. ABRAMS	515
The lipoprotein Lp(a): Structure, metabolism and significance for vascular diseases	
G. M. KOSTNER, F. KREMLER and F. SANDHOFER	527
The composition of triacylglycerols in human blood lipoproteins, milk and adipose tissue	
L. G. SZOLLÁR	535
Concluding remarks on lipoprotein metabolism, apolipoproteins, lipid constituents	
L. G. SZOLLÁR	545
Index	549

# HORMONAL RECEPTORS IN THE CELL REGULATION OF DIGESTIVE FUNCTIONS

**Serge Bonfils**

*Unité de Recherches de Gastroentérologie, INSERM U.10, Hôpital Bichat, F-75877 PARIS CEDEX 18, France*

The main digestive functions can be activated or inhibited by hormones secreted by the GEP system. Strong evidence has been presented for action of these hormones on: 1) exocrine secretions (water and electrolytes, proteins and glycoproteins); 2) motor activities (tonic and propulsive), 3) function of "survival", i.e. tissue metabolism and cell renewal. Less documented and still controversial are the possible effects on other endocrine secretions and on absorption, mainly by transcellular pathway.

But as indicated in table I, there is so far no strict identities

Table I  
HORMONAL DEPENDENCE OF DIGESTIVE FUNCTIONS

DIGESTIVE FUNCTIONS		HORMONAL RECEPTOR	HORM. STIMUL. &/or INHIB.
Exocrine secretions	Water, electrolytes	+	+
	Proteins (enzymes)	+	+
	Glycoproteins	+	+
Endocrine secretions		-	?
Motor activity	Tonic (sphincter)	+	+
	Propulsive	-	+
Absorption & intestinal transepithelial transport		+	?
Survival of cells	Metabolism	?	+
	Renewal	+	+

Comparison between evidences for hormonal receptor and for physiological actions at the organ level (-: no evidence so far; ?: no direct evidence).



between tissues undergoing hormonal influences and tissues (or cells) evidencing receptor activation and/or inhibition by the same hormones.

The concept of hormonal receptor is however highly stimulating; it particularly implies the cellular events resulting from hormone-tissue interactions, that could be considered as representative of function(s) (3). This could lead to controversial results when compared with organ physiology, all the more that in experimental approaches concerned with these effects, problems arise from the multiplicity of the GEP hormones that may interfere on a same target organ and the capability for one hormone of triggering simultaneously various physiological activities. A prerequisite for optimizing reliability and reproducibility of studies appears thus to minimize or suppress the other parameters of regulation, i.e. nervous influx, feed-back phenomena driven by the digestive secretions, blood supply.

# I. FUNCTIONAL MODELS AT THE CELL LEVELS

Ideally, receptor studies should not only encompass binding parameters, but extend to specific functional activities: technically the methods used taken alone, are well defined and rather sophisticated; however, for an ideal demonstration, four criteria should be fulfilled. 1) Homogeneity of the tissue, i.e. constituted of one cell type (eventually equipped with more than one receptor type). 2) Specificity of hormone binding to receptor; this technically needs radiolabeled hormones with full biological activities. 3) Characterization and measurement of intracellular messenger activities, in connection with 2 and 4. 4) Determination of the most relevant activity of the cell for assessing the functional response. These criteria which cover the succession of events intervening in the cell regulation of digestive functions are not often simultaneously obtained (table II).

Table II. CRITERIA FOR RECEPTOR STUDIES

CRITERIA	REQUIREMENTS
1. Homogeneity of the tissue	Isolated cells Enrichment in one cell type Group of cells with a predominant functional activity
2. Specificity of the binding	Radiolabeled hormones with full biological activity Distinction of various types of sites
3. Intracellular messenger activities	cAMP, cGMP, Ca <sup>++</sup> , protein kinases
4. Functional responses	Specific and/or relevant for organ physiology
5. Competence within the E.Ds. obtained from 2., 3., 4.	