

WEST-EUROPEAN SYMPOSIA
ON CLINICAL CHEMISTRY

VOLUME 2

The Clinical Chemistry
of Monoamines

WEST-EUROPEAN SYMPOSIA ON CLINICAL CHEMISTRY

VOLUME 2

THE CLINICAL CHEMISTRY OF MONOAMINES

MANCHESTER, 1962

organised by

The Association of Clinical Biochemists, Great Britain

edited by

HAROLD VARLEY, M.Sc., F.R.I.C.

*Biochemist, Manchester Royal Infirmary, Honorary Lecturer in Clinical Pathology,
Manchester University (Great Britain)*

and

A. H. GOWENLOCK, M.Sc., M.B., Ch.B., Ph.D.

Senior Lecturer in Chemical Pathology, Manchester University (Great Britain)



ELSEVIER PUBLISHING COMPANY

AMSTERDAM / LONDON / NEW YORK

1963

SOLE DISTRIBUTORS FOR THE UNITED STATES AND CANADA
AMERICAN ELSEVIER PUBLISHING COMPANY, INC.
52 VANDERBILT AVENUE, NEW YORK 17, N.Y.

SOLE DISTRIBUTORS FOR GREAT BRITAIN
ELSEVIER PUBLISHING COMPANY LIMITED
12b, RIPPLESIDE COMMERCIAL ESTATE
RIPPLE ROAD, BARKING, ESSEX, GREAT BRITAIN

LIBRARY OF CONGRESS CATALOG CARD NUMBER 63-11364

WITH 74 ILLUSTRATIONS AND 27 TABLES

ALL RIGHTS RESERVED
THIS BOOK OR ANY PART THEREOF MAY NOT BE REPRODUCED IN ANY FORM,
INCLUDING PHOTOSTATIC OR MICROFILM FORM,
WITHOUT WRITTEN PERMISSION FROM THE PUBLISHERS

PREFACE

When the Association of Clinical Biochemists agreed to hold its twenty third National Meeting in Manchester, it was suggested that this should take the form of a two-day symposium to which members of the sister societies in West Europe should be invited. At a meeting held on the eve of the symposium, it was decided to hold a series of West European Symposia on Clinical Chemistry. These symposia would take place annually in each of the participating countries in rotation and be published in book form. The present symposium is the second in the series, the first being considered to be the "Symposium on Water and Electrolyte Metabolism" held in Amsterdam in 1960.

The subject chosen by the Programme Committee was "The Clinical Chemistry of Monoamines", which it was intended should include adrenaline, nor-adrenaline and related amines, and the 5-hydroxyindoles. These were to be considered from the standpoints of their metabolism, methods of determination, clinical, pathological, clinical chemical, pharmacological and toxicological aspects. The symposium took the form of a series of papers by invited speakers followed by the presentation of short papers by participants and by discussion. The symposium was held at Manchester University on the 17th and 18th of July, 1962 and 197 participants attended. A list of these appears on pages vii-xii of the book. The papers are printed in full, for the most part as delivered, but in some cases where it was thought that this would increase the value of the contributions, authors have been allowed to include additional material. Short papers and discussions were recorded and edited later from the tape and from scripts submitted by the contributors. A standard system of abbreviations and nomenclature has been adopted throughout the book by the Editors. A list of these is included.

We should like to thank all those who read papers and contributed to the discussions for submitting their material for publication and to acknowledge most gratefully, generous financial assistance given by the following firms:

Ciba Laboratories Ltd., Horsham, Sussex.

Geigy Pharmaceutical Company Ltd., Roundthorn Estate, Wythenshawe, Manchester 23.

Imperial Chemical Industries Ltd., Pharmaceuticals Division, Fulshaw Hall, Wilmslow, Cheshire.

May and Baker Ltd., Dagenham, Essex.

Smith, Kline and French Laboratories Ltd., Welwyn Garden City, Herts. Their help greatly contributed towards the success of the symposium and its publication in this form.

H. Varley
A. H. Gowenlock

ORGANISING COMMITTEE

Chairman: H. Varley, M.Sc., F.R.I.C.

Joint Secretaries: M. Bell, M.Sc., A.R.I.C.
J. Hooper, B.Sc., A.R.I.C.

A.H. Gowenlock, M.Sc., M.B., Ch.B., Ph.D.
J.T. Ireland, B.Sc., A.R.I.C.

PROGRAMME COMMITTEE

Chairman: H. Varley, M.Sc., F.R.I.C.

Secretary: A.H. Gowenlock, M.Sc., M.B., Ch.B., Ph.D.

R. Gaddie, B.Sc., Ph.D., F.R.I.C.
A.L. Latner, D.Sc., M.D., M.R.C.P., F.R.I.C.
C.P. Stewart, D.Sc., Ph.D.
J.H. Wilkinson, D.Sc., Ph.D., F.R.I.C., F.P.S.

LIST OF PARTICIPANTS

- ABBS, E. T., Department of Pharmacology, School of Medicine, Leeds 2, Great Britain.
- ACLAND, J. D., Department of Pharmacology and Therapeutics, Sheffield University, Sheffield 10, Great Britain.
- AHLQUIST, K. A., Department of Pathology, Christie Hospital and Holt Radium Institute, Wilmslow Road, Manchester 20, Great Britain.
- ANDERSON, W. N., Department of Chemical Pathology, School of Medicine, Leeds 2, Great Britain.
- AULD, W. H. R., Area Laboratory, Ballochmyle Hospital, Mauchline, Ayrshire, Great Britain.
- AXELROD, J., National Institutes of Health, Bethesda, Maryland, U.S.A.
- BAIRD, J. R. C., Division of Experimental Pharmacology, Institute of Physiology, The University, Glasgow W. 2, Great Britain.
- BARNES, LILY, West Park Hospital, Macclesfield, Cheshire, Great Britain.
- BARRON, D. I., Smith Kline and French Laboratories Limited, Mundells, Welwyn Garden City, Herts., Great Britain.
- BECKER, J. F., Nuffield Department of Clinical Biochemistry, Radcliffe Infirmary, Oxford, Great Britain.
- BELL, M., Department of Clinical Pathology, Manchester Royal Infirmary, Manchester 13, Great Britain.
- BENRAAD, H. B., Wilhelminasingel 1, Nijmegen, Netherlands.
- BENTON, J. M., 1, Gordon Avenue, Graves Park, Sheffield 8, Great Britain.
- BEVAN, B. R., Department of Pathology, Southmead Hospital, Westbury-on-Trym, Bristol, Great Britain.
- BOWDEN, C. H., Royal Air Force Institute of Pathology and Tropical Medicine, Halton, Aylesbury, Bucks., Great Britain.
- BOWERS, A., 140, High Road, Halton, Lancaster, Great Britain.
- BRENAN, R. A., Biochemistry Department, General Hospital, Burton-on-Trent, Staffs., Great Britain.
- BRIDGE, A. D., 129, Clarence Road, Windsor, Berks., Great Britain.
- BROUGHTON, P. H., Department of Biochemistry, Maryfield Hospital, Dundee, Angus, Great Britain.
- BROUGHTON, P. M. G., Biochemistry Laboratory, St. John's Hospital, Chelmsford, Essex, Great Britain.
- BROWN, G. A., Institute of Child Health, Children's Hospital, Ladywood Road, Birmingham 16, Great Britain.
- BULTHUIS, MIENA, Psychiatrische Universiteitskliniek, Nicolaas Beetsstraat 24, Utrecht, Netherlands.
- BURGESS, A. M., Department of Pathology, City Hospital, Nottingham, Great Britain.
- BURTON, P., Pathology Laboratory, Ashton General Hospital, Ashton-under-Lyne, Lancs., Great Britain.
- BUTTERWORTH, E. C., 37, Court Lane, Wolstanton, Newcastle, Staffs., Great Britain.
- CALLINGHAM, B. A., Department of Pharmacology, School of Pharmacy, 29-39, Brunswick Square, London W.C. 1, Great Britain.
- CAMPBELL, A. C. P., Department of Pathology, Clinical Sciences Building, York Place, Manchester 13, Great Britain.
- CASS, ROSEMARY, Department of Pharmacology, School of Pharmacy, 29-39, Brunswick Square, London W.C. 1, Great Britain.
- CAVE, AUDREY, Pathology Department, Withington Hospital, Manchester 20, Great Britain.

- CHILDS, MAUREEN, Biochemistry Department, Southern General Hospital, Govan Road, Glasgow S.W. 1, Great Britain.
- CLARK, M.S.G., Department of Pharmacology, School of Pharmacy, 29-39, Brunswick Square, London S.W. 1, Great Britain.
- CLIFFE, E.E., Biology Division, Research Department, Boots Pure Drug Co. Ltd., Pennyfoot Street, Nottingham, Great Britain.
- CLOUGH, G., Biochemistry Laboratory, General Hospital, Knaresborough Road, Harrogate, Yorks., Great Britain.
- COLES, MARGARET E., Biochemistry Department, Institute of Medical Veterinary Science, Adelaide, S. Australia.
- CORBET, J.G., Elsevier Publishing Company, P.O. Box 211, Jan van Galenstraat 335, Amsterdam, Netherlands.
- COULSON, W.F., Courtauld Institute of Biochemistry, Middlesex Hospital, London W. 1, Great Britain.
- CROSSLAND, J., Department of Pharmacology, University of Nottingham, University Park, Nottingham, Great Britain.
- CURRY, A.S., Home Office Forensic Science Laboratory, 32, Rutland Drive, Harrogate, Yorks., Great Britain.
- DAGNALL, PHYLLIS, Royal West Sussex Hospital, Chichester, Sussex, Great Britain.
- DALGLIESH, C.E., Miles Laboratories Ltd., Stoke Court, Stoke Poges, Slough, Bucks., Great Britain.
- DAVIES, G., Pathology Department, Liverpool Radium Institute, 89, Roscoe Street, Liverpool 1, Great Britain.
- DAY, T.H., Pathology Department, Essex County Hospital, Colchester, Essex, Great Britain.
- DEUL, D.H., Psychiatry Institute, Biochemistry Department, Academic Hospital, Groningen, Netherlands.
- DIXON, JEAN M., Department of Clinical Pathology, Royal Infirmary, Manchester 13, Great Britain.
- DIXON, K., Booth Hall Hospital, Manchester 9, Great Britain.
- DOGGART, J.R., National Spinal Injuries Centre, Stoke Mandeville Hospital, Aylesbury, Bucks., Great Britain.
- DOYLE, L., Baguley Hospital, Manchester 23, Great Britain.
- DRAIN, D.J., Smith and Nephew Research Ltd., Hunsdon Laboratories, Ware, Herts., Great Britain.
- DUCKWORTH, W., 29, Grimshaw Street, Turncroft Lane, Stockport, Cheshire, Great Britain.
- EDWARDS, R.W.H., The Endocrine Laboratory, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London W.C. 1, Great Britain.
- ELLIOTT, AUDREY R., Pathology Department, Royal Infirmary, Pembroke Place, Liverpool 3, Great Britain.
- FARRANT, J., School of Pharmacy, Department of Pharmacology, 29-39, Brunswick Square, London W.C. 1, Great Britain.
- FAWNS, T.H., Department of Pathology, Royal Infirmary, Worcester, Great Britain.
- FENTON, J.C.B., Royal Victoria Infirmary, Newcastle-upon-Tyne 1, Great Britain.
- FINCH, ETHEL, Children's Hospital, Sheffield 10, Great Britain.
- FITTON, ANNABELLE, Department of Pathology, Royal Infirmary, Dundee, Angus, Great Britain.
- FLINT, MARJORIE, Area Pathology Laboratory, Westwood Hospital, Beverley, Yorks., Great Britain.
- FOOT, C.H., 37, Badminton Road, Chorlton-cum-Hardy, Manchester 21, Great Britain.
- FRAZER, S.C., Department of Clinical Chemistry, Royal Infirmary, Edinburgh, Great Britain.
- GADDIE, R., The General Hospital, Birmingham 4, Great Britain.
- GARDNER, MARY D., Biochemistry Department, Glasgow Royal Infirmary, Castle Street, Glasgow C. 4, Great Britain.

- GARRATT, C.J., Shell Research Ltd., Tunstall Laboratory, Broad Oak Road, Sittingbourne, Kent, Great Britain.
- GATT, J.A., 89, Stanley Grove, Penwortham, Preston, Lancs., Great Britain.
- GEORGES, R.J., Clinical Laboratory, Addenbrooke's Hospital, Cambridge, Great Britain.
- GJESSING, L., Dikemark Hospital, Asker, Norway.
- GLAZOWSKI, E., Walton Hospital, Liverpool 9, Great Britain.
- GOLDSTEIN, M., New York University School of Medicine, 550 First Avenue, New York 16, New York, U.S.A.
- GOWENLOCK, A.H., Department of Pathology, Clinical Sciences Building, York Place, Manchester 13, Great Britain.
- GRANT, G.H., Department of Pathology, Royal Salop Infirmary, Shrewsbury, Great Britain.
- GRANT, T.E., Beech Cottage, Lymm Road, Thelwall, Cheshire, Great Britain.
- GREEN, A.L., Smith Kline and French Research Institute, Mundells, Welwyn Garden City, Herts., Great Britain.
- GRIEVE, W.S.M., Biochemistry Department, Oldchurch Hospital, Romford, Essex, Great Britain.
- HALL, E.G., Alder Hey Children's Hospital, West Derby, Liverpool 12, Great Britain.
- HAMER, C.J.A. van den, Ornsteinsingel 10, Utrecht, Netherlands.
- HARMER, GRACE L.M., Pharmacology Group, Boots Pure Drug Co. Ltd., Pennyfoot Street, Nottingham, Great Britain.
- HEELEY, A.F., Hospital for Sick Children, Great Ormond Street, London W.C.1, Great Britain.
- HEFFERNAN, C., The Garth, Commons Lane, Balderstone, Blackburn, Lancs., Great Britain.
- HIGGINS, G., Department of Clinical Biochemistry, Radcliffe Infirmary, Oxford, Great Britain.
- HOOPER, J., Department of Pathology, Crumpsall Hospital, Manchester 8, Great Britain.
- HORMAVIRTA, HILKKA O., 45 Avenue Road, Toronto 5, Ontario, Canada.
- HORROCKS, R.H., Department of Pathology, Royal Infirmary, Bolton, Lancs., Great Britain.
- HOWELL, CAROLYN, Biochemistry Department, Queen Elizabeth Hospital, Edgbaston, Birmingham 15, Great Britain.
- HUGHES, PATTIE A., Biochemistry Department, Children's Hospital, Ladywood Road, Birmingham 16, Great Britain.
- IRELAND, J.T., 339, Brodie Avenue, Liverpool 19, Great Britain.
- JENNER, F.A., Department of Psychiatry, The University, Sheffield 10, Great Britain.
- JEPSON, J.B., Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London W.1, Great Britain.
- JONES, K.M., Department of Chemical Pathology, School of Medicine, Leeds 2, Great Britain.
- KELLEHER, J., Pathology Department, New Cross Hospital, Wolverhampton, Great Britain.
- KELLETT, J.R., Department of Pathology, St. George's Hospital, Lincoln, Great Britain.
- KENNEDY, MARY P., Department of Pathology, Walton Hospital, Liverpool 9, Great Britain.
- LANGLEY, P.F., Biochemistry Department, Beecham Research Laboratories Ltd., Brockham Park, Betchworth, Surrey, Great Britain.
- LASCELLES, P.T., Department of Chemical Pathology, United Liverpool Hospitals, 14, Ashton Street, Liverpool 3, Great Britain.
- LATNER, A.L., Department of Clinical Chemistry, Royal Victoria Infirmary, Newcastle-upon-Tyne 1, Great Britain.
- LAURSEN, T., Dronninggardsalle 83, Holte, Denmark.

- LEVELL, M. J., Department of Chemical Pathology, School of Medicine, Leeds 2, Great Britain.
- LIND, O., Medicinsk Laboratorium, Landemaerket 29, Copenhagen K, Denmark.
- LJUNGBERG, E., Psychiatric Clinic Ullcråker, Uppsala, Sweden.
- LORD, P. S., 1, Wynmore Crescent, Bramhope near Leeds, Yorks., Great Britain.
- MCCOUBREY, A., Research and Development Department, Messrs. Reckett and Son Ltd., Danson Lane, Hull, Yorks., Great Britain.
- McGOWAN, G. K., Royal Infirmary, Bristol 2, Great Britain.
- McKENDRICK, T., c/o The Hospital for Sick Children, Great Ormond Street, London W. C. 1, Great Britain.
- McMILLAN, MARY, Lewisham Group Laboratory, Lewisham Hospital, London S. E. 13, Great Britain.
- MACKAY, KATHARINE M., Ballochmyle Hospital, Mauchline, Ayrshire, Great Britain.
- MALLINSON, A., Shell Research Ltd., Tunstall Laboratory, Broad Oak Road, Sittingbourne, Kent, Great Britain.
- MANNING, G. B., Department of Pathology, Royal Infirmary, Bolton, Great Britain.
- MARSDEN, H. B., Royal Manchester Children's Hospital, Pendlebury, Lancs., Great Britain.
- MARSHALL, CHRISTINE S., 10, Clarkehouse Road, Sheffield 10, Great Britain.
- MARSHALL, P. B., Department of Pharmacology and Therapeutics, Queens College, Dundee, Great Britain.
- MATHER, N. J. de V., 26, St. John Street, Manchester 3, Great Britain.
- MERRILLS, R. J., Pfizer Limited, Sandwich, Kent, Great Britain.
- MOSS, D., Pathology Laboratory, Withington Hospital, Manchester 20, Great Britain.
- MOSSMAN, D. B., Pathology Department, General Hospital, Warrington, Lancs., Great Britain.
- MULLIGAN, DINAH, Pathology Laboratory, Royal Infirmary, Pembroke Place, Liverpool 3, Great Britain.
- NATOFF, I. L., Smith Kline and French Laboratories Ltd., Mundells, Welwyn Garden City, Herts., Great Britain.
- NIELSEN, E., Medicinsk Laboratorium, Landemaerket 29, Copenhagen K, Denmark.
- NOBLE, R. L., Department of Chemical Pathology, United Liverpool Hospitals, Ashton Street, Liverpool 3, Great Britain.
- OFFERHAUS, L., Universiteitskliniek voor Inwendige Ziekten, Binnengasthuis, Amsterdam C, Netherlands.
- OFFERMAN, J. L., Pharmacological Research Department, Pfizer Limited, Sandwich, Kent, Great Britain.
- O'KELLY, T., Queen Mary's Hospital, Roehampton, London S.W. 15, Great Britain.
- ORAM, JEAN, Pharmacology Department, Queen's College, Dundee, Great Britain.
- PADMORE, G. R. A., 45, Fulwood Hall Lane, Fulwood, Preston, Lancs., Great Britain.
- PALMER, D. B., Department of Surgery, Royal Infirmary, Bristol, Great Britain.
- PARK, DOROTHY C., Department of Chemical Pathology, Medical School, Leeds 2, Great Britain.
- PEETERS, H. J., Prof. Huybersstraat 6, Nijmegen, Netherlands.
- PENNINGTON, R. J., Department of Clinical Chemistry, Royal Victoria Infirmary, Newcastle-upon-Tyne 1, Great Britain.
- PERRYMAN, P. W., Biochemistry Department, General Hospital, Rochford, Essex, Great Britain.
- PETTEN, G. R. van, Division of Experimental Pharmacology, Institute of Physiology, The University, Glasgow W. 2, Great Britain.
- PLATT, D. S., Department of Pathology, Clinical Sciences Building, York Place, Manchester 13, Great Britain.
- PLETSCHER, A., F. Hoffmann-La Roche and Co. Ltd., Basle, Switzerland.
- PLUMMER, D. T., 1, Pleydell Gardens, Anerley Hill, London S.E. 19, Great Britain.
- POWELL, F. J. N., Pathology Unit, St. James's Hospital, Leeds 9, Great Britain.
- PRAAG, H. M. van, Vlaardingerdijk 364, Schiedam, Netherlands.

- PRIESTLAND, R. N., Oldham and District General Hospital, Rochdale Road, Oldham, Lancs., Great Britain.
- RANDRUP, A., Sct. Hans Hospital, E. Biochemistry Laboratory, Roskilde, Denmark.
- RATCLIFFE, J., 61, Walsingham Road, Woodthorpe, Nottingham, Great Britain.
- REINOUTS VAN HAGA, P., Laboratorium voor Klinische Microchemie, Nieuwe Gracht 137, Utrecht, Netherlands.
- REVILL, J. P., Nicholas Research Institute, Wexham Place, Framewood Road, Wexham, Slough, Bucks., Great Britain.
- RIGBY, C. J., Department of Pathology, Victoria Hospital, Blackpool, Great Britain.
- ROBINSON, R., Group Pathological Laboratory, Lakin Road, Warwick, Great Britain.
- ROSS, A. F., Smith and Nephew Research Ltd., Hunsdon Laboratories, Ware, Herts., Great Britain.
- RUDD, B. T., Department of Surgery, Clinical Research Unit, Queen Elizabeth Hospital, Edgbaston, Birmingham 15, Great Britain.
- RUTHVEN, C. R. J., Bernhard Baron Memorial Research Laboratories, Queen Charlotte's Maternity Hospital, Goldhawk Road, London W. 6, Great Britain.
- RUYSSEN, R. G., University of Ghent, St. Jansvest 12, Ghent, Belgium.
- SAMMONS, H. G., Metabolic Unit, Little Bromwich General Hospital, Birmingham 9, Great Britain.
- SANDLER, M., Bernhard Baron Memorial Research Laboratories, Queen Charlotte's Maternity Hospital, Goldhawk Road, London W. 6, Great Britain.
- SCHIEVELBEIN, H., Klinisch-Chemisches Institut an der Chirurgischen Universitätsklinik, Nussbaumstrasse 20, Munich, Germany.
- SCHMID, E., Medizinische Universitätsklinik, Erlangen, Germany.
- SCHOLTIS, R. J. H., Mgr. Leytenstraat 42, Breda, Netherlands.
- SCOTT, JANET W., Biochemistry Department, Stobhill General Hospital, Glasgow N. 1, Great Britain.
- SEAKINS, J. W. T., Hospital for Sick Children, Great Ormond Street, London W. C. 1, Great Britain.
- SEBENING, F., Klinisch-Chemisches Institut an der Chirurgischen Universitätsklinik, Nussbaumstrasse 20, Munich, Germany.
- SEWELL, P. F. J., Department of Clinical Pathology, General Hospital, Birmingham 4, Great Britain.
- SMALL, N. A., Department of Pathology, Southmead General Hospital, Westbury-on-Trym, Bristol, Great Britain.
- SMITH, A., Department of Therapeutics, Royal Infirmary, Sheffield 6, Great Britain.
- SMITH, A. D., Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London W. 1, Great Britain.
- SMITH, P., Royal Air Force Institute of Aviation Medicine, Farnborough, Hants., Great Britain.
- SMITH, R., St. Luke's Hospital, Little Horton Lane, Bradford, Yorks., Great Britain.
- SNOW, P. J. D., Royal Infirmary, Bolton, Lancs., Great Britain.
- SOMERVILLE, A. R., Imperial Chemical Industries Ltd., Pharmaceuticals Division, Alderley Park, Macclesfield, Cheshire, Great Britain.
- SPENCER, R. W., Department of Pathology, Royal Cornwall Infirmary, Truro, Cornwall, Great Britain.
- SPRIGGS, T. L. B., Department of Pharmacology, School of Pharmacy, 29-39, Brunswick Square, London W. C. 1, Great Britain.
- STEEL, A. E., Biochemistry Department, Killingbeck Hospital, York Road, Leeds 14, Great Britain.
- STEWART, C. P., Department of Clinical Chemistry, Royal Infirmary, Edinburgh, Great Britain.
- STOTT, A. W., 5, New Street, Tottington, Bury, Lancs., Great Britain.
- STREET, H. V., Department of Forensic Medicine, The University, Edinburgh, Great Britain.
- STRENGERS, Th., Vredelaan 5, Laren (N.H.), Netherlands.

- SUMMERSCALES, JEAN W., Department of Chemical Pathology, Medical School, Leeds 2, Great Britain.
- SUTCLIFFE, K.W., 23, Gibwood Road, Northenden, Manchester 22, Great Britain.
- TARNOKY, A.L., Royal Berkshire Hospital, Reading, Berks., Great Britain.
- THOMPSON, J.C., Group Laboratory, Lewisham Hospital, London S.E. 13, Great Britain.
- THORBURN, ANNE R., Department of Materia Medica and Therapeutics, University Medical Buildings, Foresterhill, Aberdeen, Great Britain.
- THURNHAM, D., Smith and Nephew Research Ltd., Hunsdon Laboratories, Ware, Herts., Great Britain.
- TODRICK, A., Department of Clinical Research, Crichton Royal, Dumfries, Great Britain.
- TOOTHILL, C., Department of Chemical Pathology, School of Medicine, Leeds 2, Great Britain.
- TRAVERSE, P.M. de, Institut de Biologie Clinique de l'Université, 27, Faubourg St. Jaques, Paris XIV, France.
- VALLANCE, D.K., Smith Kline and French Laboratories, Mundells, Welwyn Garden City, Herts., Great Britain.
- VARLEY, H., Department of Clinical Pathology, Royal Infirmary, Manchester 13, Great Britain.
- WAELE, J. de, Ingenhouszstraat 43, Utrecht, Netherlands.
- WALTON, ANNE J., Department of Clinical Pathology, Royal Infirmary, Manchester 13, Great Britain.
- WARBURTON, F.G., 27, Whitegate Park, Flixton, Manchester, Great Britain.
- WERLE, E., Klinisch-Chemisches Institut an der Chirurgischen Universitätsklinik, Nussbaumstrasse 20, Munich, Germany.
- WEST, GWEN, Biochemistry Department, Queen Elizabeth Hospital, Edgbaston, Birmingham 15, Great Britain.
- WEST, G.B., Department of Pharmacology, School of Pharmacy, 29-39, Brunswick Square, London W.C. 1, Great Britain.
- WHITBY, L.G., Biochemistry Department, Tennis Court Road, Cambridge, Great Britain.
- WHITEHEAD, T.P., Biochemistry Department, Queen Elizabeth Hospital, Edgbaston, Birmingham 15, Great Britain.
- WHITTLE, B.A., 9, Eden Close, Wilmslow, Cheshire, Great Britain.
- WILDING, P., Nutrition Laboratory, General Hospital, Birmingham 4, Great Britain.
- WILKINSON, G.S., 108, Princes Boulevard, Bebington, Cheshire, Great Britain.
- WILKINSON, J.H., Westminster Medical School, 17, Horseferry Road, London S.W. 1, Great Britain.
- WILLEY, G.L., Smith Kline and French Research Institute, Mundells, Welwyn Garden City, Herts., Great Britain.
- WILLS, M.R., Department of Pathology, Royal Infirmary, Bristol, Great Britain.
- WILSON, H., Department of Pharmacology, The University, Liverpool, Great Britain.
- WILSON, VERA K., Willow House, Penistone near Sheffield, Great Britain.
- WISLICKI, L., Department of Pharmacology, Medical School, The University, Manchester 13, Great Britain.
- YATES, CELIA M., Department of Clinical Research, Crichton Royal, Dumfries, Great Britain.
- YATES, F.H., Department of Pathology, Victoria Hospital, Blackpool, Great Britain.
- YEOMAN, W.B., Dudley Road Hospital, Birmingham 18, Great Britain.
- ZIMPRICH, H., Universitäts-Kinderklinik, Wien 9, Austria.

ABBREVIATIONS AND NOMENCLATURE

In the following list, the terms in the left hand column are the ones used throughout this book:

Adrenaline	epinephrine
Adrenochrome	5,6-quinone of 2,3-dihydro-3-hydroxy-1-methylindole
Bufotenin	N,N-dimethyltryptamine
CNS	central nervous system
CSF	cerebrospinal fluid
DHMA	3,4-dihydroxymandelic acid
Dopa	3,4-dihydroxyphenylalanine
Dopac	3,4-dihydroxyphenylacetic acid
Dopachrome	5,6-quinone of 2,3-dihydroindole-2-carboxylic acid
Dopamine	β -3,4-dihydroxyphenylethylamine, 3-hydroxytyramine
Epinine	N-methyldopamine
5-HIAA	5-hydroxyindole-3-acetic acid
HMMA	4-hydroxy-3-methoxymandelic acid, VMA
HMPG	4-hydroxy-3-methoxyphenyl glycol
Homovanillic acid	4-hydroxy-3-methoxyphenylacetic acid
5-HT	5-hydroxytryptamine, serotonin, enteramine
5-HTP	5-hydroxytryptophan
LSD	lysergic acid diethylamide
MAO	monoamine oxidase
Melatonin	N-acetyl-5-methoxytryptamine
Metadrenaline	3-O-methyladrenaline, metanephrine
NAD	nicotinamide-adenine dinucleotide, DPN
NADP	nicotinamide-adenine dinucleotide phosphate, TPN
Noradrenaline	norepinephrine
Normetadrenaline	3-O-methylnoradrenaline, normetanephrine
Octopamine	β -p-hydroxyphenyl- β -hydroxyethylamine
Synephrine	N-methyloctopamine
THI	trihydroxyindole
Tryptamine	β -3-indolyethylamine
Tyramine	β -p-hydroxyphenylethylamine

DRUGS

Wherever possible, we have used the Approved Name selected by the British Pharmacopoeia Commission instead of one of the many proprietary names. In most cases, the name in use in the U.S.A. is identical, but where it differs, the American name follows the Approved Name in brackets, e.g. Nialamide (Niamide). In the case of Methyl dopa, we have preferred to use the term, α -Methyl dopa, in order to avoid possible confusion in the catecholamine field where N-methylation and O-methylation is so common. In the few cases where no Approved Name exists, we have employed the term quoted by the author.

CONTENTS

Preface	v
Organising committees	vi
List of participants	vii
Abbreviations and nomenclature	xvi
Introduction	
by A. L. Latner (Newcastle-upon-Tyne)	1
THE CLINICAL CHEMISTRY OF CATECHOLAMINES	
Main papers	
The formation, metabolism, uptake and release of noradrenaline and adrenaline by Julius Axelrod (Bethesda, Md.)	5
The determination of catecholamines in biological materials by B. A. Callingham and Rosemary Cass (London)	19
The determination of metabolites of catecholamines by chromatographic techniques by Peter Smith (Farnborough)	31
The determination of metabolites of catecholamines by other techniques by C. R. J. Ruthven (London)	39
Pathological and clinical features of phaeochromocytoma by R. Winston Evans (Liverpool)	48
The clinical chemistry of phaeochromocytomas by Ronald Robinson (Warwick)	63
Clinical and pathological features of neuroblastoma by H. B. Marsden (Pendlebury, Lancashire)	71
The clinical chemistry of neuroblastomas by Maurice Bell (Manchester)	82
Short papers	
Some aspects of the biosynthesis and metabolism of catecholamines by Menek Goldstein (New York, N. Y.)	92
Some observations on the application of the trihydroxyindole reaction to the estimation of adrenaline and noradrenaline by George Clough (Harrogate, Yorks.)	94
Thin-layer chromatography in the diagnosis of phaeochromocytoma and malignant argentaffinoma by Eberhard Schmid, L. Zicha and J. Krautheim (Erlangen)	97
Discussion	99

THE CLINICAL CHEMISTRY OF 5-HYDROXYINDOLES

Main papers

The formation and metabolism of hydroxyindoles by J. B. Jepson (London)	107
The determination of hydroxyindoles in biological materials by Merton Sandler (London)	116
Clinical aspects of carcinoid tumours by P. J. D. Snow (Bolton)	131
The pathology of carcinoid tumours by A. C. P. Campbell (Manchester)	135
The clinical chemistry of carcinoid tumours by A. H. Gowenlock and D. S. Platt (Manchester)	140
Short papers	
Levels of 5-hydroxytryptamine in patients undergoing open-heart surgery with the aid of extracorporeal circulation by Eugen Werle, Helmut Schievelbein and F. Sebening (Munich)	165
Release of 5-hydroxytryptamine by nicotine and lobeline by Helmut Schievelbein (Munich)	167
Some studies of 5-hydroxyindole metabolism in patients without carcinoid disease by Eberhard Schmid (Erlangen)	168
5-Hydroxyindole-3-acetic acid excretion in the urine, a specific diagnostic sign in fatal catatonia by Ewart Ljungberg (Uppsala)	169
Discussion.	171

PHARMACOLOGICAL AND TOXICOLOGICAL ASPECTS OF MONOAMINES

Main papers

The role of the monoamines in excitation and depression of the central nervous system by James Crossland (Nottingham)	175
Drug-induced alterations of monoamine metabolism by Alfred Pletscher (Basle)	191
The toxicology of monoamine oxidase inhibitors and tranquillisers by A. S. Curry (Harrogate)	205
Short papers	
Urinary excretion of 4-hydroxy-3-methoxymandelic acid: effect of prolonged treatment of psychiatric patients with reserpine and chlorpromazine by A. A. Randrup, E. Boje Rasmussen and I. Munkvad (Roskilde)	215
A critical investigation of the importance of monoamine oxidase inhibitors as a thera- peutic principle in the treatment of depression by H. M. van Praag (Rotterdam)	217
Influence of an inhibitor of monoamine oxidase upon haemostatic reactions by Eberhard Schmid, S. Witte and K. T. Schricker (Erlangen)	220
Discussion	222

CONTENTS

xv

OTHER TOPICS

Short papers

The origin and structure of melanins

by J. M. Rangier (Paris) 225

Investigation of an amine fraction of human urine

by A. D. Smith and J. B. Jepson (London) 227

Index 231

INTRODUCTION BY THE PRESIDENT OF THE ASSOCIATION OF CLINICAL BIOCHEMISTS

A. L. LATNER

Department of Clinical Chemistry, King's College and
Royal Victoria Infirmary, Newcastle-upon-Tyne (Great Britain)

In opening this Symposium on the Clinical Chemistry of Monoamines it is a pleasure to welcome you all to Manchester to discuss this very topical and extremely important field. I am particularly pleased to see our visitors from abroad and to note the fact that they include Prof. Dr. Ruysen, President of the Belgian Society of Clinical Chemistry, Prof. Dr. Werle, President of the Section of Clinical Chemistry in the German Society of Physiological Chemistry, Prof. de Traverse, President of the French Society of Biological Chemistry and Dr. Strengers, President of the Dutch Association of Clinical Chemistry.

With regard to our contributors, I am looking forward very much to hearing the communication from Dr. Axelrod whose work on 3-O-methylation and other aspects of catecholamine metabolism puts him amongst the world's leaders in this field. Recently a new metabolite has been isolated from the urine of patients suffering from schizophrenia [1]. It appears to be 3,4-dimethoxyphenylethylamine, and its presence would suggest that there is a 4-O-methyltransferase in schizophrenic patients. Although the results must be viewed with caution, this could be an important breakthrough in the biochemical understanding of this disease. It will be a privilege to hear what Dr. Axelrod has to say about this and other aspects of 4-O-methylation. I am also looking forward with great expectation to Prof. Pletscher's remarks dealing with the effects of drugs on monoamine metabolism. This is an extremely important field of modern therapeutics and he is indeed an acknowledged expert.

Studies in relation to monoamines lead us into very widespread fields, ranging from the diagnosis of phaeochromocytoma on the one hand to psychiatric medicine on the other. There seems little doubt in relation to the latter aspect that careful study has led to scientific methods of exorcizing those devils of the mind which have possessed the mentally bewitched. Indeed, a great contribution to human happiness, as well as an important step to the eventual understanding of mental processes, has been made through these studies. There seems little doubt that 5-hydroxytryptamine (5-HT) is in some way concerned with higher nervous function, although it must be admitted that we have no real evidence as yet which points precisely to its mode of action, but the neurobiochemist is rapidly producing a good deal of evidence in this field and no doubt much valuable information will be derived.

In relation to physical medicine, the study of catecholamine metabolites is proving extremely important both in the diagnosis of phaeochromocytoma and of neuroblastoma. Studies of the metabolites of 5-HT are also playing an important part in diagnosis, especially in regard to carcinoid tumours and other

biochemically related conditions. Dr. Jepson's authoritative remarks on the metabolism of the hydroxyindoles will further educate us in this field.

There has been some confusion in the clinical chemical laboratory with regard to the various technical methods used. I am, therefore, looking forward very much to what Mr. Ruthven has to say about the methods of determination of 4-hydroxy-3-methoxymandelic acid and other related catecholamine metabolites as well as to Dr. Smith's remarks on chromatographic techniques. Dr. Sandler's information in relation to hydroxyindoles will, I hope, go a long way to standardizing methods in this field.

Monoamine oxidase inhibitors and many of the tranquillizers are threatening to become popular with potential suicides. In this country, there is no greater authority on this subject than Dr. Curry. We shall have much to learn from what he has to say about his valuable experiences in relation to the toxicology of tranquillizers and the like.

Whilst I have not mentioned all of the speakers by name, it suffices for me to say that each is an acknowledged expert in his particular field and that we have been particularly happy in our choice. There is no doubt that we shall hear much of interest and value and that we shall leave this Symposium much wiser than when we arrived. I am sure that nothing but good can come from this type of collaboration involving clinicians, morbid anatomists, psycho-pharmacologists, physiologists and biochemists. It must inevitably lead to an integrated concept of molecular pathology which, when combined with advancing knowledge of molecular biology, will lead to much greater understanding of the living organism and its disorders.

REFERENCE

1. A. J. Friedhoff and E. van Winkle, *Nature*, 194 (1962) 897.