

TODD-SANFORD

CLINICAL DIAGNOSIS

By Laboratory Methods

15th edition

Edited by

ISRAEL DAVIDSOHN, M.D., F.A.C.P

Professor of Pathology and Chief, Division of Experimental Pathology,
University of Health Sciences, The Chicago Medical School and
Director, Department of Experimental Pathology,
Mount Sinai Hospital Medical Center, Chicago, Illinois

JOHN BERNARD HENRY, M.D.

Dean, College of Health Related Professions,
Professor of Pathology, College of Medicine, and Director,
Division of Clinical Pathology, University Hospital, State
University of New York, Upstate Medical Center, Syracuse, New York

W. B. SAUNDERS COMPANY • Philadelphia • London • Toronto

W. B. Saunders Company: West Washington Square
Philadelphia, Pa. 19105

12 Dyott Street
London, WC1A 1DB

833 Oxford Street
Toronto, Ontario M8Z 5T9, Canada

Clinical Diagnosis by Laboratory Methods

ISBN 0-7216-2922-9

© 1974 by W. B. Saunders Company. Copyright 1908, 1912, 1914, 1918, 1923, 1927, 1931, 1935, 1939, 1943, 1948, 1953, 1962, and 1969 by W. B. Saunders Company. Copyright under the International Copyright Union. All rights reserved. This book is protected by copyright. No part of it may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission from the publisher. Made in the United States of America. Press of W. B. Saunders Company. Library of Congress Catalog card number 8-27796.

Print No.: 9 8 7 6 5 4 3 2

CONTRIBUTORS

DENNIS L. ALLEN, M.D.

Family Practice Resident, Ball Memorial Hospital, Muncie, Indiana

MYRTON FREEMAN BEELER, M.D.

Professor, Departments of Pathology and Preventive Medicine, Louisiana State University Medical Center, New Orleans; Associate Pathologist, Charity Hospital of Louisiana, Consultant in Clinical Pathology, V.A. Hospital, New Orleans, Louisiana

ELLIS S. BENSON, M.D.

Professor and Head, Department of Laboratory Medicine and Pathology, University of Minnesota Medical School, Minneapolis, Minnesota

G. MARY BRADLEY, M.D.

Associate Professor, Department of Laboratory Medicine and Pathology, University of Minnesota Medical School, Minneapolis, Minnesota

DONALD C. CANNON, M.D., Ph.D.

Director, Bio-Science Laboratories, Van Nuys, California; Visiting Professor of Pathology, The University of New Mexico School of Medicine, Albuquerque, New Mexico

BRADLEY ELLSWORTH COPELAND, M.D.

Chairman, Department of Pathology, New England Deaconess and New England Baptist Hospitals, Boston, Massachusetts

ISRAEL DAVIDSOHN M.D., F.A.C.P.

Professor of Pathology and Chief, Division of Experimental Pathology, University of Health Sciences, The Chicago Medical School, Chicago; Director, Department of Experimental Pathology, Mount Sinai Hospital Medical Center, Chicago, Illinois

ROBERT R. EGGEN, M.D.

Acton, Massachusetts

RAOUL FRESCO, M.D., Ph.D.

Associate Professor of Pathology, University of Health Sciences, The Chicago Medical School; Head, Division of Electron Microscopy, Mount Sinai Medical Center, Chicago, Illinois

MILTON GOLDIN, Ph.D.

Clinical Associate Professor, University of Health Sciences, The Chicago Medical School, Chicago; Director, Microbiology, Mount Sinai Hospital Medical Center, Chicago, Illinois

JOHN BERNARD HENRY, M.D.

Dean, College of Health Related Professions, Professor of Pathology, College of Medicine, and Director, Division of Clinical Pathology, University Hospital, State University of New York, Upstate Medical Center, Syracuse, New York

YUAN S. KAO, M.D.

Assistant Professor of Pathology, Louisiana State University School of Medicine, New Orleans; Visiting Pathologist, Charity Hospital of Louisiana, New Orleans, Louisiana

ARTHUR F. KRIEG, M.D.

Professor of Pathology, The Pennsylvania State University, Hershey; Director, Division of Clinical Pathology, The Milton S. Hershey Medical Center, Hershey, Pennsylvania

ROBERT G. LANCASTER, M.D.

Assistant Clinical Professor of Pathology, University of Maryland School of Medicine, Baltimore; Director, Department of Pathology and School of Medical Technology, Mercy Hospital, Baltimore, Maryland

ROBERT D. LANGDELL, M.D.

Professor of Pathology, University of North Carolina School of Medicine, Chapel Hill, North Carolina

CHANG LING LEE, M.D.

Professor of Pathology, University of Health Sciences, The Chicago Medical School, Chicago; Director, Charles Hymen Blood Center, Mount Sinai Hospital Medical Center, Chicago, Illinois

JESSE H. MARYMONT, JR., M.D.

Assistant Director of Laboratories, Wesley Medical Center, Wichita, Kansas

RUSSELL M. McQUAY, Ph.D.

Adjunct Assistant Professor of Microbiology, University of Health Sciences, The Chicago Medical School; Director of Microbiology, Division of Medical Parasitology, Mount Sinai Hospital Medical Center, Chicago, Illinois

DOUGLAS A. NELSON, M.D.

Professor of Pathology, Associate Director of Clinical Pathology, Director Program in Medical Technology, State University of New York, Upstate Medical Center, Syracuse, New York

DANIEL C. NIEJADLIK, M.D.

Assistant Clinical Professor of Pathology, University of Texas Medical School, San Antonio; Assistant Laboratory Director, Wilford Hall Medical Center, U.S.A.F., San Antonio, Texas

ALAN L. ORVIS, Ph.D.

Associate Professor of Biophysics, Mayo Graduate School of Medicine, University of Minnesota, Rochester; Consultant, Department of Therapeutic Radiology, Mayo Clinic and Mayo Foundation, Rochester, Minnesota

ALLEN L. PUSCH, M.D.

Associate Professor, Pathology, State University of New York, Upstate Medical Center, Syracuse; Deputy Director, Clinical Pathology, State University Hospital, Syracuse, New York

JERALD M. ROSENBAUM, M.D.

Pathologist and Director of Clinical Chemistry, Department of Pathology, Springfield Hospital Medical Center, Springfield, Massachusetts

JAMES G. SHAFFER, Sc.D., D.Sc. (Honorary)

Professor of Microbiology and Associate Dean, University of Health Sciences, The Chicago Medical School, Chicago; Consultant in Hospital Epidemiology, Lutheran General Hospital, Park Ridge, and Mount Sinai Hospital Medical Center, Chicago, Illinois

S. THOMAS SHAW, JR., M.D.

Assistant Professor of Obstetrics and Gynecology and of Pathology, Los Angeles County/

University of Southern California Medical Center, Los Angeles, California

KURT STERN, M.D.

Professor, Department of Life Sciences, Bar-Ilan University, Ramat-Gan, Israel; Professor Emeritus of Pathology, University of Illinois College of Medicine, Chicago, Illinois

W. NEWLON TAUXE, M.D., M.S. (Pathology)

Associate Professor of Clinical Pathology, Mayo Graduate School of Medicine, University of Minnesota, Rochester; Consultant, Department of Diagnostic Nuclear Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minnesota; Professor of Nuclear Medicine and Clinical Pathology, Division of Nuclear Medicine, University of Alabama, Birmingham, Alabama

HARRY F. WEISBERG, M.D.

Associate Clinical Professor of Pathology and of Medicine, University of Wisconsin Medical School, Madison; Associate Clinical Professor of Health Sciences, University of Wisconsin, Milwaukee; Lecturer in Medical Technology, Carroll College, Waukesha; Associate Director, Department of Pathology, and Director of Division of Biochemistry and of School of Medical Technology, Mount Sinai Medical Center, Milwaukee, Wisconsin

ROBERT E. WENK, M.D.

Acting Pathologist-in-Chief, Sinai Hospital of Baltimore, Inc., Baltimore, Maryland

WEI T. WU, Ph.D.

Clinical Assistant Professor, Louisiana State University School of Medicine, New Orleans; Staff, Charity Hospital of Louisiana, New Orleans, Louisiana

HYMAN J. ZIMMERMAN, M.D.

Professor of Medicine, George Washington University School of Medicine; Clinical Professor, Georgetown University and Howard University Schools of Medicine; Chief, Medical Service, Veterans Administration Hospital, Washington, D.C.

PREFACE

With this 15th edition, Todd and Sanford reaches the mature age of 66 years of service to a third generation of clinical pathologists, medical technologists, medical students, internists and family physicians.

Our objectives or goals in this edition include the following:

1. Identify appropriate measurements and examinations for:
 - a. diagnosis.
 - b. confirmation of a clinical impression.
 - c. screening or detection of disease.
 - d. prognosis.
 - e. therapeutic or management guideline data.
2. Indicate the order in which such measurements and examinations should be requested.
3. Interpret and translate laboratory findings.
4. Recognize pitfalls, problems and limitations of laboratory data, including discussion of quality control and drug interaction as well as relative merits in terms of methodology, patient preparation and communication.
5. Understand pathophysiology or sequence of disease as reflected by laboratory measurements and examinations.

Since it is virtually impossible to compress all of laboratory medicine into a single volume, we have chosen to emphasize certain topics that have compelling practical application with the patient as the central theme. Thus, the fields of chemical pathology, hematology and medical microbiology have been greatly expanded in the form of a series of chapters.

It is significant that this edition begins with a chapter on statistics and quality control and concludes with a chapter on clinical laboratory computerization: the two subjects identify a basic approach to laboratory science and currently have a pre-eminent role throughout the medical laboratory.

In the appendices, tables of normal values incorporate much data from our own laboratories as well as those of other workers. Body surface area and desirable weights are important in terms of blood volume and measurements of selected organ functions.

Our contributors have been chosen on the basis of great knowledge and current activity in their disciplines. We are grateful to these distinguished scientists who have been faithful to their task and gracious in cooperation.

ISRAEL DAVIDSOHN
JOHN BERNARD HENRY

ACKNOWLEDGMENTS

A work of multiple authorship requires by its very nature the willingness of the contributors to accept the guidance of the editors. We are glad to acknowledge that our collaborators have been most gracious in this respect.

Several individuals have been particularly helpful with suggestions and careful review of selected manuscripts, galley proofs and page proofs: Drs. Frederick Davey, Maurice Furlong, Harold Hawley, Judy Mercer, Daniel Niejadlik, Barry Pearson, Jeffrey Pevnick, Allen Pusch, Charles Rouault, Gloria Sage, Solomon Schreiber, Gerald Simon, Avrum Stein, Howard Weindling, William Welch, Mrs. Shirley Klein, Reginaldo Lauzon, and Miss Bettina Martin, all of Clinical Pathology; Dr. Mary Voorhess, Department of Pediatrics; Drs. Robert Levine and Joan Howanitz, Department of Medicine; Dr. Raja Abdul-Karim, Department of Obstetrics-Gynecology; State University of New York, Upstate Medical Center in Syracuse. Dr. Raymond Troxler at Brooks Air Force Base, Texas, provided invaluable assistance in lipids and Dr. Maurice Furlong provided comparable assistance for proteins in our chemistry chapter, while Dr. F. Donald McGovern assisted in endocrinology. To Dr. George Linke we are particularly grateful for his assistance in the revision of Appendix 2 and his critical analysis of specific portions of the chemistry chapter, particularly on methodology. Dr. Howard Zirkin assisted by critically reviewing several chapters.

For verification of references, we are again indebted to Mr. Clark Rumsey and Mrs. Evelyn Hoey at the Upstate Medical Center Library. Appreciation is also due Mr. Louis Georgianna and Mildred Knowles for photographic assistance and to Mrs. Julia Hammock for contributions in medical illustration.

We should also like to acknowledge the stimulus and efforts of former residents and medical students as well as colleagues who have helped in so many ways to bring this edition to completion.

For sustained devotion and meticulous attention to detail, we are grateful to our secretaries, Miss Carol Mosher, Mrs. Judy Meggesto, Miss Sharon Putney, and Mrs. Marilyn Yarbrough.

To Dr. James N. Patterson, we extend our sincere thanks for bringing us together.

We want to express our appreciation for the cooperation of Mr. Robert B. Rowan, Mr. Herbert Powell, and Mrs. Billie Brick as well as the entire staff of the W. B. Saunders Company.

I.D.

J.B.H.

CONTENTS

Chapter 1

STATISTICAL TOOLS IN CLINICAL PATHOLOGY	1
<i>by Bradley E. Copeland, M.D.</i>	
Selecting the Abnormal Individual	1
Guaranteeing Reliable Measurements	2
Evaluation of Change in a Single Patient: The Significant Change Limit	9
Summary	11
Case Histories	11

Chapter 2

EXAMINATION OF THE URINE	15
<i>by G. Mary Bradley, M.D., and Ellis S. Benson, M.D.</i>	
History	15
Composition of the Urine	16
Examination of the Urine: General Comments	18
Procedure for Routine Screening Urinalysis	18
Urinary Screening for Inborn Errors of Metabolism	19
Quality Control	20
Examination of the Urine Sediment	21
Common Renal Diseases	39
Physicochemical Tests	40
Urinary Calculi	77
Collection of Urine	79

Chapter 3

RENAL FUNCTION AND ITS EVALUATION	84
<i>by S. Thomas Shaw, Jr., M.D., and Ellis S. Benson, M.D.</i>	
Elements of Renal Physiology	84
Renal Hemodynamics and Glomerular Filtration	84
Tubular Function	85
Principles of Renal Clearance	85
Methods of Clearance Measurement	87
Measurements of Renal Function	88
Glomerular Filtration Rate	88
Renal Blood Flow and Effective Renal Plasma Flow	89
Tubular Function Tests	91
Interpretation of Results	95
Creatinine Clearance and Plasma Concentration	96
PSP Excretion	97
Concentration Tests	98
Tests for Renal Ischemia Producing Hypertension	98

Chapter 4

THE BLOOD.....	100
<i>by Israel Davidsohn, M.D., and Douglas A. Nelson, M.D.</i>	
METHODS USED IN THE STUDY OF BLOOD.....	100
Methods of Obtaining Blood	100
Hemoglobin.....	104
Determining the Concentration of Hemoglobin.....	105
Abnormal Hemoglobin Pigments.....	111
Hematocrit (Packed Cell Volume)	115
Blood Cell Counting	116
Hemocytometer.....	117
Electronic Counting	121
Red Cell-Corpuscular Values; Red Cell Indices	123
Leukocyte Count	124
Platelet Count	126
Multichannel Instruments.....	128
Volume of Blood and Plasma.....	130
Fragility Tests; Erythrocyte Osmotic Fragility.....	130
Erythrocyte Sedimentation Rate.....	133
Examination of Stained Blood Films.....	135
Erythrocytes: Morphology.....	141
Leukocytes: Morphology, production, function	149
Platelets: morphology, production, function	157
Production and Destruction of Erythrocytes	158
Examination of Marrow.....	168
Vital Staining.....	177
HEMATOLOGIC CHANGES IN DISEASE.....	180
Types of Hematologic Examination.....	181
The Anemias	181
Erythrokinetics.....	184
Blood-loss Anemia	186
Impaired Formation of Erythrocytes Due to Deficiency of Essential Nutrients	186
Impaired Formation of Erythrocytes <i>Not</i> Due to Deficiency of Essential Nutrients	193
Hemolytic Anemias.....	198
Hemolytic Anemias Due to Intrinsic Abnormalities.....	201
Hemoglobinopathies and Thalassemia	206
Hemolytic Anemias Due to Extrinsic (Extracorporeal) Factors	221
IMMUNOHEMATOLOGY	223
Immune Diseases of the Blood and Blood-forming Tissues.....	223
Isoimmune diseases	223
Classification of Autoimmune Hemolytic Anemias	229
Acquired Hemolytic Anemias Caused by Incomplete Warm Autoantibodies	231
Acquired Hemolytic Anemias Caused by Cold Antibodies.....	233
Drug-induced Immune Hemolytic Anemias.....	235
Anemia in Pregnancy.....	236
Laboratory Diagnosis of Anemias.....	237
Polycythemia.....	241
Hematopoiesis in the Newborn and Infant.....	244
Disorders Involving Leukocytes	245
Neutrophils	246
Eosinophils.....	255
Basophils.....	256
Lymphocytes.....	256
Monocytes	266
Plasma cells	267
Proliferative Disorders of Blood-producing Tissues; Blood and Marrow Findings	267
Leukemia	267
Malignant Lymphoma	286
Blood Protein Disorders	289
Myeloproliferative Syndromes	292

Leukemoid Reactions	294
Hypersplenism	295
The LE (Lupus Erythematosus) Cell Test	296
Variations of Blood Platelets in Disease	301

Chapter 4—Addendum

ULTRASTRUCTURE OF THE BLOOD CELLS AND THEIR PRECURSORS	311
--	-----

by Raoul Fresco, M.D., Ph.D.

Life Cycle of the Normal Erythrocyte	312
Gaucher's Disease	316
Sickle Cell Anemia	318
Sideroblastic Anemia	318
Maturation of Granulocytes	320
Neutrophilic Granulocyte	324
Eosinophilic Granulocyte	324
Basophilic Granulocyte	326
Mast Cell	326
Acute Granulocytic Leukemia	328
Chronic Granulocytic Leukemia	328
Lymphocyte	330
Monocyte	330
Infectious Mononucleosis	332
Chronic Lymphocytic Leukemia	334
Monocytic Leukemia	334
Lymphosarcoma Cell Leukemia	336
Reticulum Cell Sarcoma	336
Plasma Cell	338
Multiple Myeloma	340
Megakaryocytes	344
Platelets and Fibrin	346

Chapter 5

BLOOD GROUPS AND THEIR APPLICATION	348
--	-----

by Kurt Stern, M.D., Chang-Ling Lee, M.D., and Israel Davidsohn, M.D.

Immunohematology of Red Cells	348
Theory of Blood Group Systems	349
Hemagglutination Techniques	365
Practical Applications of Hemagglutination Tests	388
Quality Control	408
Reagents	408
Blood Specimens	408
Instruments and Supplies	408
Procedures	409
Immunohematology of Leukocytes	409
Immunohematology of Platelets	411

Chapter 6

COAGULATION AND HEMOSTASIS	414
----------------------------------	-----

by Robert D. Langdell, M.D.

Blood Platelets	416
Vascular Factors	418
Plasma Coagulation Factors	419
Fibrinogen	419
Prothrombin	421
Thromboplastin	422
Calcium	422

Factor V.....	423
Factor VII.....	424
Factor VIII.....	425
Factor IX.....	426
Factor X.....	427
Factor XI.....	428
Factor XII.....	428
Factor XIII.....	429
Vascular Hemophilia.....	429
Vitamin K and Antivitamin K Drugs.....	430
Disseminated Intravascular Coagulation.....	431
Acquired Anticoagulants.....	432
Fibrinolysis.....	432
Procedures.....	434
Automated Procedures.....	434
 Chapter 7	
NUCLEAR MEDICINE PROCEDURES IN THE CLINICAL LABORATORY.....	449
<i>by W. Newlon Tauxe, M.D., and Alan L. Orvis, Ph.D.</i>	
Radionuclide Physics.....	449
Diagnostic Tests.....	461
Tests of Thyroid Function.....	462
Renal Tests.....	470
Hematologic Tests.....	474
Tests of Gastrointestinal Tract and Spleen.....	480
Neurological Applications.....	484
Body Composition Studies.....	494
Competitive Binding Assay Procedures.....	495
Safety and Regulations.....	495
Design of the Radioisotope Laboratory.....	496
 Chapter 8	
SPECTROPHOTOMETRIC INSTRUMENTATION.....	499
<i>by Robert G. Lancaster, M.D.</i>	
Spectrophotometry.....	499
Components of a Spectrophotometer.....	500
Direct Reading and Null Point Systems.....	507
Beer's Law.....	508
Flame Photometry.....	510
Fluorometry.....	512
The Art and Science of Spectrophotometry.....	513
 Chapter 9	
CLINICAL CHEMISTRY.....	516
<i>by John Bernard Henry, M.D.</i>	
Specimen Collection and Processing.....	516
Drug Interference in Clinical Chemistry.....	524
Records and Reporting of Results.....	529
Mathematics and Chemical Calculations.....	532
Laboratory Safety.....	537
Laboratory Glassware.....	540
Laboratory Equipment and Materials.....	541
Basic Techniques.....	543
Mass or Weight.....	544
Volume.....	544
Titrimetry.....	544

Chromatography	547
Electrophoresis	552
Micro- and Ultramicroanalysis	554
Automation and Semiautomation	554
Nitrogenous Compounds	560
Biochemistry	561
Analytical Techniques for Protein Determination	565
The Plasma Proteins	568
Immunoglobulins	571
Clinicopathologic Correlations	577
Nonprotein Nitrogenous (NPN) Compounds	591
Urea Nitrogen (BUN)	591
Creatine and Creatinine	594
Uric Acid	596
Carbohydrates	599
Glucose	601
Clinicopathologic Correlations	604
Diabetes Mellitus	604
Screening Tests	606
Diagnostic Tests	607
Laboratory Aspects of Management	609
Hypoglycemia	609
Methods for Estimation	610
Lipids	612
Chemical Reactions	614
Hepatic Role In Lipid Metabolism	616
Triglyceride Metabolism	617
Cholesterol Metabolism	619
Blood Lipids	621
Lipoproteins	622
Clinicopathologic Correlations	624
Lipid Storage Diseases	631
Methods	632
Cholesterol	635
Triglyceride	636
Lipoprotein Electrophoresis	638
Inorganic Ions	639
Biochemistry of Calcium and Phosphorus	639
Bone	642
Parathormone	642
Vitamin D	643
Calcitonin	644
Clinicopathologic Correlations	646
Bone Diseases	646
Parathyroid Diseases	649
Methods	650
Iron	652
Copper	656
 Chapter 10	
CLINICAL TOXICOLOGY AND DRUG ASSAYS	665
<i>by Dennis L. Allen, M.D., and John Bernard Henry, M.D.</i>	
Alcohols and Other Volatiles	667
Ethanol	667
Methanol	670
Other Volatiles	671
Amphetamines	671
Antiepileptics	671
Barbiturates and Glutethimide	673
Barbiturates	673
Glutethimide	675

Bromides	676
Cardiac Glycosides	677
Hallucinogens	678
Metals	679
Arsenic	679
Iron	679
Lead	680
Lithium	681
Mercury	682
Hemoglobin Derivatives	683
Carboxyhemoglobin	683
Cyanmethemoglobin and Cyanide	684
Methemoglobin	684
Sulfhemoglobin	685
Narcotics	685
Cocaine	685
Opiates	686
Quinine	686
Specimens, Methods, and Interpretation	686
Phenothiazines	688
Salicylates	689
Description of Methods	690

Chapter 11

ENDOCRINE MEASUREMENTS	697
------------------------------	-----

by John Bernard Henry, M.D., and Arthur F. Krieg, M.D.

Cyclic AMP	698
The "Second Messenger" Concept	699
Clinicopathologic Correlations	699
Hormones of the Hypothalamus and Pituitary	700
Posterior Pituitary Hormones (Vasopressin or ADH and Oxytocin)	701
Anterior Pituitary Hormones	702
Growth Hormone (GH)	702
Thyrotropin (TSH)	703
Gonadotropins (FSH and LH)	704
Corticotropin (ACTH)	705
Polypeptide Hormone Production by Tumors	705
Adrenal Cortex and Steroid Hormones	706
Biosynthesis of Adrenocorticosteroids	708
Regulation of Secretion	708
Transport Metabolism and Excretion	712
Biologic Effects and Diagnostic Methods	714
Measurement of Adrenocorticosteroids (Corticoids, Corticosteroids)	716
17-Ketosteroids (17-KS)	716
Androgens	717
17-Hydroxycorticosteroids (17-OH)	719
17-Ketogenic Steroids (17-KGS)	721
Aldosterone	722
Evaluation of Hypertensive Patient	724
Clinicopathologic Correlations	726
Methods of Analyses	732
Estrogen and Progesterone	733
Estrogen	733
Progesterone	735
Testosterone	736
FSH and LH	736
Adrenal Medulla	736
Biochemical and Physiologic Considerations	737
Clinicopathologic Correlations	739
Total Catecholamines	740

Vanillylmandelic Acid (VMA).....	740
Homovanillic Acid (HVA).....	740
Differential Catecholamine Assay	741
Method for VMA	741
Thyroid	742
Normal Anatomy.....	742
Thyroid Hormone Synthesis	742
Serum Transport of Thyroid Hormones	744
Peripheral Actions of Thyroid Hormones	744
Regulation of Thyroid Gland	745
Pathophysiology	746
Classification of Thyroid Disease.....	747
Goiter	747
Thyroid Tumors	749
Thyroiditis	750
Graves' Disease.....	751
Hypothyroidism and Myxedema	752
Laboratory Measurements of Thyroid Function	754
Measurements of Thyroid Hormones	755
Radioimmunoassays	757
Estimates of the Inverse of Unoccupied Thyroxine-Binding Sites	758
Indicators of Free Thyroxine and Free Hormone Concentration	760
Measurements of Thyroxine-Binding Protein	761
Measurement of Thyroid-Stimulating Hormones.....	761
Radioactive Iodine Uptake and Related Measurements.....	762
Estimates of Thyroid Hormone Effect on Target Organs.....	765
Clinicopathologic Correlations	765

Chapter 12

WATER, ELECTROLYTES, ACID-BASE, AND OXYGEN.....	772
---	-----

by Harry F. Weisberg, M.D.

Water	772
Water Balance.....	773
Electrolytes	773
Cations	773
Anions	776
Anion-Cation Electroneutrality	781
Osmolality	782
Acid-Base Equilibrium.....	785
Bicarbonate Deficit	792
Carbonic Acid Excess	792
Bicarbonate Excess	794
Carbonic Acid Deficit	795
Other Schemes.....	796
Oxygen	797

Chapter 13

TESTS OF HEPATIC FUNCTION	804
---------------------------------	-----

by Hyman J. Zimmerman, M.D.

Bilirubin Metabolism.....	806
Tests	811
Metabolic Tests	812
Carbohydrate Metabolism	812
Lipid Metabolism.....	813
Protein Metabolism.....	814
Foreign Substance Excretion	818
Rose Bengal Excretion	819
Sulfobromophthalein (BSP) Excretion	819
Indocyanine Green Excretion.....	821

Detoxification and Synthesis.....	821
Hippuric Acid Excretion.....	821
Prothrombin Level and Vitamin K Response	821
Enzyme Levels of Blood	822
Alkaline Phosphatase	823
Transaminase (GOT and GPT).....	824
Serum "Metals".....	829
Liver Function Tests Based on Role of Liver in Vitamin Economy	829
Liver Biopsy	829
Radioisotopes in Diagnosis of Hepatic Disease.....	830
Serologic Tests.....	831
Clinical Application of Liver Function Tests	832
Hepatic Function in Nonhepatic Disease	832
Conclusions	835

Chapter 14

SERUM ENZYME DETERMINATIONS AS AN AID TO DIAGNOSIS.....	837
---	-----

by Hyman J. Zimmerman, M.D., and John Bernard Henry, M.D.

Principles of Enzyme Determinations.....	837
Principles of Diagnostic Serum Enzymology.....	843
Phosphatases.....	846
Transaminases	848
Glycolytic Enzymes	851
Lactic Dehydrogenase (LD)	852
"Citric Acid Cycle" Enzymes.....	855
Hexose "Shunt" Enzymes.....	856
Cholinesterase.....	856
Ornithine Carbamoyl Transferase (OCT).....	858
5'-Nucleotidase (5'-N).....	860
Creatine Phosphokinase (CPK)	860
Other Serum Enzymes	860
Clinical Application of Serum Enzyme Assay	860
Serum Enzymes in Myocardial Infarction	863
Serum Enzymes in Liver Disease.....	863
Muscle Disease	864
Neoplastic Disease	864
Enzymes of the Formed Elements of the Blood.....	864
Hemolytic Anemia Associated with Deficiency of Erythrocyte Enzymes.....	865
Hemolytic Anemia Secondary to Deficiency of Glutathione Reductase (GR), Glutathione Peroxidase (GSH-Px) or Glutathione Synthetase.....	867
Hemolytic Anemias Secondary to Deficiency in Glycolytic Enzymes	867
Systemic Diseases Reflected in Abnormal Erythrocyte and Leukocyte Enzymes	867
Enzyme Concentrations in Other Body Fluids.....	868

Chapter 15

LABORATORY EVALUATION OF PANCREATIC DISORDERS.....	870
--	-----

by Myrton F. Beeler, M.D., and Wei T. Wu, Ph.D.

Amylase.....	370
Methodology.....	871
Diagnostic Application of Amylase Determination	871
Lipase.....	874
Methodology.....	874
Diagnostic Application of Serum Lipase Determination	874
Secretin Test.....	875
Miscellaneous Laboratory Tests in Acute Pancreatitis	875
Miscellaneous Laboratory Tests in Chronic Pancreatitis and Pancreatic Carcinoma	876
Sweat Electrolytes by Pilocarpine Iontophoresis.....	876
Diagnostic Application of Sweat Testing.....	876

CONTENTS

xix

Proteolytic Enzymes in Feces	876
Methods and Methodology Discussion	877
Amylase Determination (Serum, Urine, Duodenal Aspirate, Peritoneal Fluid)	877
Automated Amylase Assay (Wu and Beeler, 1972)	880
Lipase Determination (Serum, Urine) [Vogel and Zieve, 1963]	881
Sweat Electrolytes by Pilocarpine Iontophoresis (Gibson and Cooke, 1959)	883
Secretin Test (Dreiling and Hollander, 1948)	884
Stool Proteolytic Activity (Johnstone, 1952)	884
Chapter 16	
EXAMINATION OF GASTRIC AND DUODENAL CONTENTS	887
<i>by Donald C. Cannon, M.D., Ph.D.</i>	
Examination of Gastric Contents	887
Physiology of Gastric Secretion	888
Composition of Gastric Secretion	888
Nomenclature of Gastric Secretion	890
Gastric Intubation	891
Physical Examination of Gastric Contents	892
Microscopic Examination of Gastric Contents	892
Tests of Gastric Function	893
Miscellaneous Studies	899
Recently Introduced Procedures in Gastric Analysis	899
Tests of Gastric Function No Longer Recommended for Routine Clinical Use	900
Examination of Duodenal Contents	901
Pancreatic Exocrine Secretion	901
Bile	901
Succus Entericus	901
Duodenal Intubation	901
Physical Examination of Duodenal Contents	902
Microscopic Examination of Duodenal Contents	902
Bacteriologic Examination of Duodenal Contents	902
Chemical Examination of Duodenal Contents	903
Examination of Stimulated Bile	903
Chapter 17	
THE EXAMINATION OF FECES	905
<i>by Myrton F. Beeler, M.D., and Yuan S. Kao, M.D.</i>	
Specimen Collection	905
Inspection of Feces	906
Mucus	906
Pus	906
Blood	906
Methodology for Blood in Feces	907
Steatorrhea	910
The Malabsorption Syndrome	910
Laboratory Diagnosis	910
Miscellaneous Procedures	913
Methodology Appendix	913
Fecal Fat	915
Fecal Reducing Substances	917
Chapter 18	
MEDICAL MICROBIOLOGY	921
<i>by James G. Shaffer, Sc.D., and Milton Goldin, Ph.D.</i>	
General Methods	923

General Techniques of Microbiologic Examinations	923
Sterilization	923
Handling Contaminated Materials	924
Preparation and Sterilization of Media	924
Quality Control in Clinical Microbiology	926
Methods of Examination of Specimens	927
Fluorescence Microscopy	929
Aerobic Culture Methods	933
Anaerobic Culture Methods	935
Choice of Media	937
Specific Methods for Microbiologic Examination of Specimens	938
Mouth, Sputum, and Bronchial Secretions	938
Cerebrospinal Fluid Cultures	946
Urine Cultures	947
Urethral, Prostatic, and Vaginal Exudates	948
Skin Lesions: Wounds, Boils, Furuncles, and Exudates	951
Infections of the Eye	952
Ear, Mastoid, Sinuses, and Antrum	952
Blood Culture Technique	952
Microbiologic Examination of the Feces	954
Bacteria of Clinical Significance	957
The Gram-positive Cocci	957
The Gram-negative Cocci	963
The Gram-negative Enteric Bacilli	967
The Nonfermentative Gram-negative Rods	978
Hemophilus, Bordetella, Moraxella, and Calymmatobacterium (Donovania)	981
Brucella, Yersinia, and Pasteurella	985
The Gram-positive Aerobic Bacilli	987
Anaerobic Non-spore-forming Gram-negative Rods	995
Vibrios, Spirillae, and the Spirochetes	996
The Acid-fast Bacilli (Mycobacteria)	998
Antimicrobial Susceptibility Tests	1008
Choice of Method for Susceptibility Testing	1009
Procedures	1010
Antimicrobial Levels in Body Fluids	1015
Susceptibility of Mycobacteria to Chemotherapeutic Agents	1016

Chapter 19

MEDICAL PARASITOLOGY..... 1020

by Russell M. McQuay, Ph.D.

Medical Protozoology	1020
The Intestinal Amebae (Rhizopoda)	1020
Miscellaneous Amebae	1034
The Intestinal Ciliates (Ciliata)	1034
The Intestinal Flagellates (Mastigophora)	1035
Other Trichomonads of Medical Importance	1036
The Systemic Flagellates	1037
Genus Leishmania	1037
Other Species of Leishmania	1037
Genus Trypanosoma	1039
The Sporozoa	1040
Genus Plasmodium	1040
Medical Helminthology	1051
The Nematodes	1052
The Hookworms	1069
The Cestodes	1070
The Trematodes	1075