

**A MANUAL OF SELECTED  
BIOCHEMICAL METHODS AS  
APPLIED TO URINE, BLOOD  
AND GASTRIC ANALYSIS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649129058

A manual of selected biochemical methods as applied to urine, blood and gastric analysis by  
Frank P. Underhill

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**FRANK P. UNDERHILL**

**A MANUAL OF SELECTED  
BIOCHEMICAL METHODS AS  
APPLIED TO URINE, BLOOD  
AND GASTRIC ANALYSIS**



U.

# A MANUAL OF SELECTED BIOCHEMICAL METHODS

AS APPLIED TO  
*Urine, Blood and Gastric Analysis*

BY  
FRANK P. UNDERHILL, Ph.D.

*Professor of Pharmacology and Toxicology,  
School of Medicine, Yale University*

177090  
26.12.22

NEW YORK  
JOHN WILEY & SONS, Inc.  
LONDON: CHAPMAN & HALL, LIMITED  
1921

## PREFACE

---

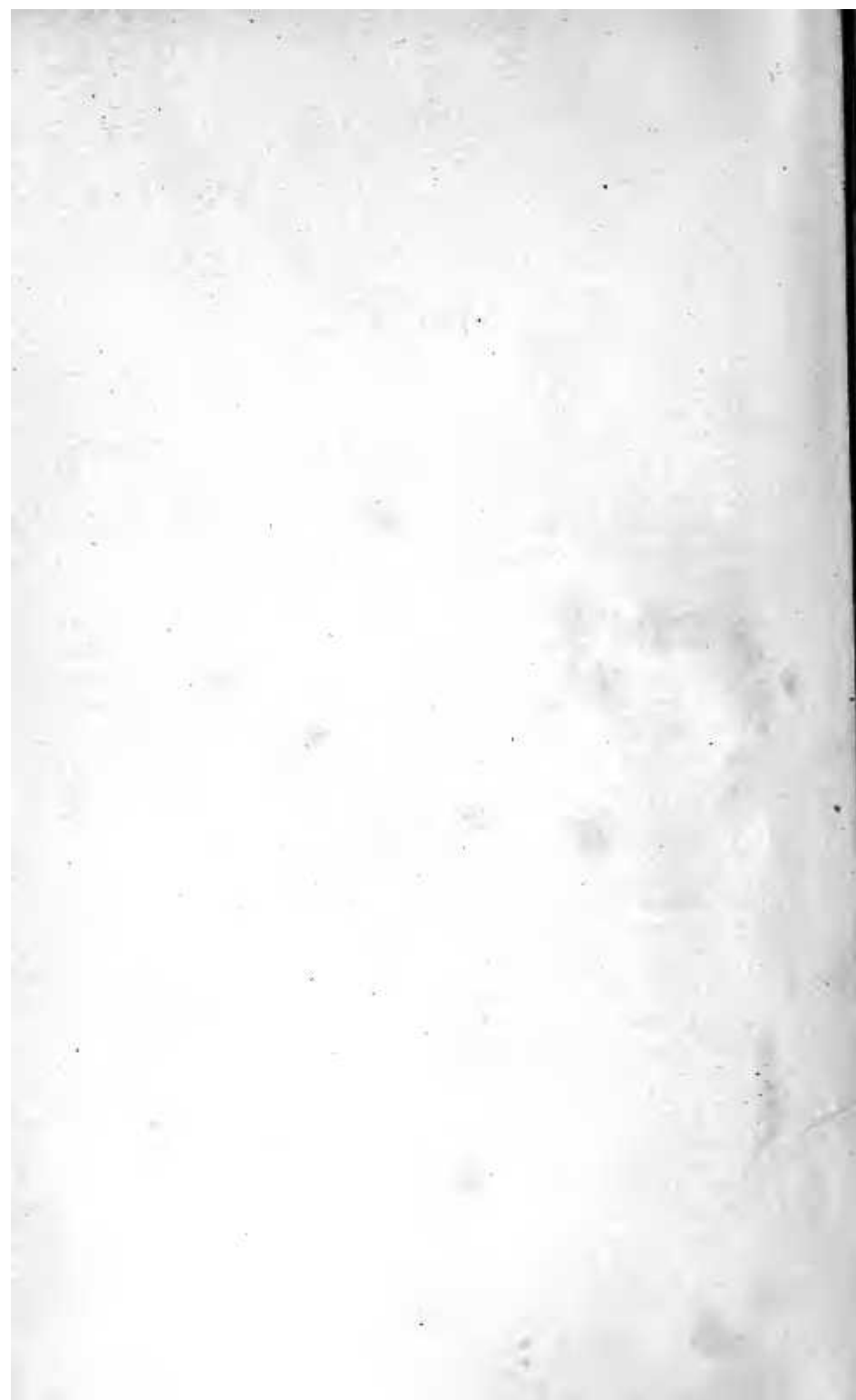
THIS manual is the outgrowth of a course in biochemical methods given by the undersigned in the Yale School of Medicine. Requests for copies of the mimeographed manual have been so numerous that it has seemed desirable to print it in book form. With this point in view several methods not originally in the course have been included in order to give the manual a more general application. It is believed that the methods herein described will meet not only the needs of medical schools desiring a fundamental course in biochemical methods, but will also be useful for physicians, research and commercial laboratories, and hospitals.

No claim of originality is made for any of the methods. They have been compiled from such sources as the *Journal of Biological Chemistry*, the *American Journal of Physiology*, *Journal of Physiology*, etc., various text books, such as Hawk's *Practical Physiological Chemistry*, Macleod's *Physiology and Biochemistry in Modern Medicine*, Folin's *Manual of Biological Chemistry*, Treadwell-Hall *Analytical Chemistry*, Fresenius-Cohn *Quantitative Chemical Analysis*, etc.

To Dr. Michael Ringer I am indebted for aid in selecting and testing methods and to Miss M. Eloise Montague my thanks are due for preparation of the manuscript and proof reading.

FRANK P. UNDERHILL.

NEW HAVEN,  
July 1, 1921.



## CONTENTS

	PAGE
To the Student.....	xi
General Directions of Work.....	xiii

### *PART I.—GENERAL METHODS*

Measuring Instruments.....	1
Calibration of Volumetric Apparatus.....	2
Use of Pycnometers.....	4
Use of Balance.....	4
Indicators.....	6
Acidimetry and Alkalimetry.....	10
Standardization of Oxidizing Solutions.....	15

### *PART II.—METHODS FOR THE ANALYSIS OF URINE*

Acidity by Titration.....	21
Titration of Organic Acids.....	22
Hydrogen Ion Concentration or True Acidity (Henderson and Palmer).....	25
Hydrogen Ion Concentration (Haskin).....	27
Total Solids	
Drying Method.....	32
Long's Coefficient.....	32
Total Nitrogen	
Kjeldahl Method.....	33
Kjeldahl Method Simplified.....	34
Kjeldahl Micro Method.....	36
The Colorimeter.....	37
Urea Methods	
Urease Methods (Van Slyke and Cullen).....	38
Urease Methods (Marshall).....	40
Urease Methods (Folin).....	41
Ammonia	
Folin's Method.....	42
Micro Method.....	44
Creatinine	
Folin's Colorimetric Method.....	44
Folin's Micro Method.....	46
Shaffer's Method for Dilute Solutions.....	47



	PAGE
Creatine	
Folin-Benedict Method.....	47
Micro Method of Folin.....	48
Uric Acid	
Folin-Shaffer Method.....	49
Micro Method.....	50
Method of Folin and Wu.....	51
Purine Bases	
Krüger and Schmidt's Method.....	53
Amino-Acid Nitrogen	
Formol Titration Method.....	55
Van Slyke—Total Amino-Acid <i>N</i> .....	57
Van Slyke—Free Amino-Acid <i>N</i> .....	58
Hippuric Acid	
Method of Folin and Flanders.....	58
Glucose	
Fehling's Method.....	59
Benedict's Method.....	61
Acetone Bodies	
Van Slyke's Methods.....	62
Folin's Methods.....	66
Indican	
Ellinger's Method.....	68
Phenols	
Method of Folin and Denis.....	69
Sulphur	
Total Sulphur—Benedict's Method.....	72
Total Sulphates—Folin's Method.....	73
Inorganic Sulphates—Folin's Method.....	74
Etheral Sulphates—Folin's Method.....	74
Total Phosphates	
Uranium Acetate Method.....	75
Chlorides	
Volhard-Arnold Method.....	76
Volhard-Harvey Method.....	77
Calcium and Magnesium	
McCrudden's Methods.....	78
Calcium in Foods and Feces.....	80
Iron.....	80
Phenolsulphonephtalein Test for Kidney Efficiency.....	81
<i>PART III.—METHODS FOR THE ANALYSIS OF BLOOD</i>	
Total Solids.....	83
Ash.....	83
System of Folin and Wu.....	83
Non-Protein Nitrogen.....	85 /

## CONTENTS

vii

	PAGE
Urea.....	87
Creatinine.....	90
Creatine.....	92
Uric Acid.....	92
Sugar.....	95
Total Nitrogen.....	97
Ammonia	
Folin and Denis Method.....	97
Urea	
Urease Method (Van Slyke and Cullen).....	97
Uric Acid	
Benedict's Method.....	98
Creatine and Creatinine	
Folin's Methods.....	101
Amino-Acid Nitrogen (Preparation of Blood Filtrate)	
Van Slyke and Meyer.....	102
Greenwald and Boek.....	103
Aliphatic Amino Groups	
Van Slyke's Method.....	104
Sugar	
Benedict's Method.....	110
Hydrogen Ion Concentration.....	112
Gas Analysis	
Haldane's Method.....	114
Henderson-Smith Method.....	119
Oxygen Capacity	
Van Slyke's Method.....	124
Carbon Dioxide Capacity	
Gasometric—Van Slyke and Cullen.....	127
Titration—Van Slyke, Stillman and Cullen.....	134
Alveolar Carbon Dioxide Tension	
Marriott's Method.....	138
Fridericia's Method.....	141
Acid Excretion in Urine (Alkali Reserve)	
Method of Fitz and Van Slyke.....	143
Alkali Tolerance.....	144
Nephelometric Methods.....	146
(a) Acetone Bodies.....	148
(b) Fat.....	151
Acetone Bodies	
Method of Van Slyke and Fitz.....	152
Cholesterol	
Method of Bloor.....	154
Method of Lichtenthaler.....	156
Calcium	
Method of Lyman.....	158
Method of Marriott and Howland.....	160
Method of Kramer and Howland.....	163

	PAGE
<b>Magnesium</b>	
Method of Marriott and Howland.....	165
Method of Denis.....	167
<b>Phosphoric Acid</b>	
Method of Marriott and Haessler.....	170
Method of Bloor.....	171
<b>Sodium</b>	
Method of Kramer.....	183
Method of Doisy and Bell.....	184
Method of Kramer and Tisdall.....	189
<b>Potassium</b>	
Method of Clausen.....	191
Method of Kramer.....	194
<b>Iron</b>	
Method of Berman.....	197
<b>Chlorides</b>	
Method of Whitehorn.....	200
Method of Van Slyke and Donleavy.....	202
Method of Meyers and Short.....	204
Method of Austin and Van Slyke.....	205
<b>Hemoglobin</b>	
Method of Haldane.....	206
Method of Palmer.....	207
Method of Cohen and Smith.....	208
<b>Methemoglobin</b>	
Method of Stadie.....	210
<b>Carbon Monoxide</b>	
Method of Van Slyke and Salversen.....	212
 <i>PART IV.—METHODS FOR THE ANALYSIS OF GASTRIC JUICE</i>	
The Fractional Method of Gastric Analysis.....	215
Töpfer's Method.....	225
<b>INDEX</b> .....	229