

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

---

**Cambridge Natural Science Manuals.**  
**BIOLOGICAL SERIES.**

GENERAL EDITOR :—ARTHUR E. SHIPLEY, M.A.  
FELLOW AND TUTOR OF CHRIST'S COLLEGE, CAMBRIDGE.

THE  
SOLUBLE FERMENTS  
AND  
FERMENTATION.

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

---

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

THE  
SOLUBLE FERMENTS  
AND  
FERMENTATION

BY

J. REYNOLDS GREEN, Sc.D., F.R.S.

TRINITY COLLEGE, CAMBRIDGE;

PROFESSOR OF BOTANY TO THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN

FORMERLY SENIOR DEMONSTRATOR IN PHYSIOLOGY IN

THE UNIVERSITY OF CAMBRIDGE.

*SECOND EDITION.*

CAMBRIDGE:  
AT THE UNIVERSITY PRESS.

1901

Cambridge University Press  
978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition  
J. Reynolds Green  
Frontmatter  
[More information](#)

---

**CAMBRIDGE**  
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

Published in the United States of America by Cambridge University Press, New York

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

[www.cambridge.org](http://www.cambridge.org)

Information on this title: [www.cambridge.org/9781107673953](http://www.cambridge.org/9781107673953)

© Cambridge University Press 1899

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First edition 1899

First published 1899

Second edition 1901

First paperback edition 2014

*A catalogue record for this publication is available from the British Library*

ISBN 978-1-107-67395-3 Paperback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

## PREFACE.

THE various problems connected with the phenomena of fermentation have received attention during the past ten years from so many investigators in different countries, and are occupying the minds of so many people to-day, that it has seemed desirable to put together, as far as possible, the results reached up to the present time, and to put forward a view of our present position with regard to the whole subject.

The recent discovery by Büchner of *zymase*, the enzyme which is capable of setting up alcoholic fermentation, has attracted renewed attention to the whole question, and has for the first time clearly shown what has long been suspected, that the production of alcohol must fall into line with the other processes of decomposition which have for some years now been included under the one name of fermentation.

It has appeared to the writer desirable for many reasons to lay stress on the relations existing between fermentation in the broad sense and the general metabolic phenomena of living organisms. Recent discoveries have shown more and more plainly what a prominent part is played by enzymes in intracellular metabolism, till it has become clear that the distinction drawn between organised and unorganised ferments is based upon an incomplete acquaintance with the metabolic processes in both higher and lower organisms, and must now be abandoned entirely in the light of fuller knowledge. The discovery of *zymase*, already alluded to, causes the disappearance of almost the last resting-place of the distinction.

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

vi

## PREFACE.

As soon as we cease to associate fermentation solely with the lowly forms of living organisms, the vitalistic theory of the writers of the school of de Latour and Pasteur, which makes alcoholic fermentation especially the expression of that life under different conditions of nutrition or aeration, is seen to be no longer sufficient to embrace all the facts. The more recent work takes the subject beyond the stage at which it was left by Pasteur, showing us that precisely similar operations are incidental to the life of the higher organisms. It thus becomes necessary to enquire into the relationship of protoplasm to metabolism, and to the association of ferments or enzymes with the living substance, and so to establish the intimate relationship of fermentation to the ordinary metabolic processes. It becomes possible to go further than this, and to consider by what chemical or physical processes the observed changes or decompositions are effected by protoplasm or by its secretions.

The comparatively recent speculations of Emil Fischer upon the configuration of the enzymes and the various bodies they attack, based as they are upon careful and painstaking investigations, direct us towards a new chemical hypothesis of their action, which, while not contravening the views of the vitalistic school of the earlier observers, certainly extends, if it does not complete them. That the work of enzymes will be ultimately shown to be chemical rather than physical in nature is rendered probable by the able researches of Croft Hill, to which attention is called at the conclusion of this work.

J. REYNOLDS GREEN.

CAMBRIDGE,  
*April*, 1899.

## PREFACE TO THE SECOND EDITION.

IN the two years which have elapsed since the publication of this work there has been a large increase in the number of memoirs bearing upon its subject. I have endeavoured, without unduly extending the size of the volume, to incorporate into it the bulk of the new matter and to include the principal memoirs, numbering more than a hundred, into the bibliography at the end. Several new enzymes have been discovered, *hadromase*, *tannase*, *lotase*, *galactase* and *vesiculase*, besides several oxidases, and some which effect reduction instead of oxidation. These will be found treated of in their appropriate connexions.

In issuing this new edition I should like to express my appreciation of the kindness of my scientific friends in welcoming the work as they have done.

J. REYNOLDS GREEN.

CAMBRIDGE,  
*April*, 1901.

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

---



## CONTENTS.

### CHAPTER I.

#### THE NATURE OF FERMENTATION AND ITS RELATION TO ENZYMES.

Early views of fermentation ; work of Becher, Leuwenhoek, Lavoisier ; discovery of the true nature of yeast by de Latour, Schwann, and Kützing ; views of Pasteur, Liebig, and Naegeli. Discovery of enzymes ; organised and unorganised ferments ; vital phenomena of protoplasm and its relation to fermentation. Characteristics of enzymes ; classification.  
pp. 1—14.

### CHAPTER II.

#### DIASTASE. (*AMYLASE, PTYALIN.*)

Discovery of diastase ; work of Kirchoff, Leuchs, Payen and Persoz ; different sources of diastase. Diastase of translocation ; its distribution ; occurrence in seeds, leaves, tubers, pollen, fungi. Diastase of secretion ; structure of the scutellum ; variations in secretion during germination ; the aleurone-layer of grasses and its relation to diastase ; differences between the two varieties of vegetable diastase ; diastase in *Bacteria*.  
pp. 15—32.

### CHAPTER III.

#### ANIMAL DIASTASE.

Discovery of diastase in saliva and in pancreatic juice ; distribution in the animal body ; secretion of saliva ; antecedent of diastase ; diastase in the liver ; distribution of diastase in the Invertebrata. pp. 33—44.

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

x

## CONTENTS.

## CHAPTER IV.

## PREPARATION OF DIASTASE AND ITS COURSE OF ACTION.

Methods of preparation ; work of Cohnheim, Krawkow, von Wittich Mialhe, Lintner, Loew, and Musculus. Action of diastase on starch ; products of the action ; theories of starch transformation ; nature of the sugar produced ; maltose ; isomaltose. Transformations of starch in plants. Is diastase a mixture of enzymes ? Action of diastase on glycogen. pp. 45—63.

## CHAPTER V.

## CONDITIONS OF THE ACTION OF DIASTASE.

Liquefying and hydrolysing powers of diastase ; diastases from different sources and their relative activities ; effect of various foreign substances on diastasic action. Conditions of the secretion of diastase ; stimulus of nutrition ; stimulus of starvation ; nervous action ; object of the secretion. pp. 64—76.

## CHAPTER VI.

## INULASE.

Occurrence, properties and distribution of inulin ; discovery of inulase ; distribution of the enzyme ; products of its action ; conditions necessary for its activity. pp. 77—85.

## CHAPTER VII.

## CYTASE, AND OTHER CELLULOSE-DISSOLVING ENZYMES.

Composition of the cell-wall ; celluloses and pectoses. Cytase in *Peziza*, and in *Botrytis* ; mode of preparation from these fungi. Cytase in the cereal grasses ; the scutellum and the aleurone-layer ; cytase in the endosperm of *Tamus* and in the seeds of Palms ; in *Bacteria*. Products of the action of cytase. Caroubinase. Hadromase, the wood-dissolving enzyme. Wiesner's Gum-ferment. pp. 86—109.

## CONTENTS.

xi

## CHAPTER VIII.

## SUGAR-SPLITTING ENZYMES.

Characters of the sugars. Inversion of cane-sugar by acids. Discovery of invertase; its distribution in the vegetable and in the animal organism; modes of preparation of invertase; its course of action and the effect of various conditions upon it; its importance in metabolism.

pp. 110—127.

## CHAPTER IX.

SUGAR-SPLITTING ENZYMES (*continued*).

Glucose and its action on malt-sugar. Digestion of maltose in the small intestine; glucose in the secretions of the pancreas and the small intestine; in various fungi, in malt and maize; in serum and lymph; in other animal secretions; in the liver and other organs; in yeast. Action of glucose on glucosides. Trehalase, its distribution and action; preparation of trehalase; differences between glucose and trehalase. Raffinase. Melitase. Lactase.

pp. 128—145.

## CHAPTER X.

## GLUCOSIDE-SPLITTING ENZYMES.

Nature of glucosides. Emulsin and its action. Distribution of emulsin; researches of Guignard, Gérard, and Bourquelot; conditions of the action of emulsin. Myrosin and its action; localisation of myrosin; peculiarities of its action. Erythrozyme. Rhamnose. Gaultherase. Tannase. Lotase. Other enzymes of this class.

pp. 146—171.

## CHAPTER XI.

## PROTEOLYTIC ENZYMES. PROTEOLYSIS.

Products of the decomposition of proteids by acids. Researches of Kühne. Decomposition of proteids by pepsin and trypsin. Researches of Meissner and Kühne. Later work of Neumeister and of Chittenden. Hydrolysis. Objections to Kühne's views.

pp. 172—185.

## CHAPTER XII.

PROTEOLYTIC ENZYMES (*continued*).

Pepsin. Methods of preparation. Work of Scheffer, Brücke, Maly, Loew, and Pekelharing. Distribution of pepsin; peculiarities of its action; effect of various conditions on pepsin; decomposition of vegetable proteids and gelatin. Action of pepsin on other substances. Trypsin; its occurrence in pancreatic juice; separation from other enzymes; Kühne's method of preparation; distribution of trypsin in the Invertebrata. Conditions of the action of trypsin; products of its activity. Intracellular digestion by trypsin. Differences between pepsin and trypsin. Galactase. pp. 186—208.

## CHAPTER XIII.

PROTEOLYTIC ENZYMES (*continued*). VEGETABLE TRYPSINS.

Bromelin; its occurrence in the Pine-apple; modes of preparation; course of action; conditions affecting it. Papain and its preparation; action on animal and vegetable proteids; conditions affecting the action of papain. Trypsin in seeds; action on fibrin and on the proteids of the seed. Zymogen of trypsin. Proteolysis in cereal grasses. Trypsin of *Agave*, *Ficus*, *Cucumis*. Proteolytic enzymes of the insectivorous plants. Trypsin in *Yeast* and in *Bacteria*. Casease. Identity of animal and vegetable trypsins. pp. 209—235.

## CHAPTER XIV.

FAT-SPLITTING ENZYMES. LIPASE. (*PIALYN*, *STEAP SIN*.)

Digestion of fat in the alimentary canal. Discovery of lipase; its distribution in the animal kingdom; methods of identification; differences between serum lipase and pancreatic lipase; lipase in the vegetable kingdom. pp. 236—249.

## CHAPTER XV.

## THE CLOTTING ENZYMES. RENNET.

Characteristics of the clotting enzymes. Rennet, and its action on milk; casein and tyrein. Sources of rennet, modes of preparation. Relation of rennet to calcium salts; theories of the action of rennet. Peculiarities of pancreatic rennet. Vegetable rennet, and its distribution. pp. 250—265.

## CONTENTS.

xiii

## CHAPTER XVI.

THE CLOTTING ENZYMES (*continued*).THROMBASE, (*THROMBIN*), THE FIBRIN-FERMENT.

Phenomena of the coagulation of the blood; early researches; the work of Schmidt and Hammarsten. Discovery of thrombase; its preparation from serum and from fibrin; nature of thrombase. Conditions affecting coagulation; influence of calcium salts; zymogen of thrombase; inhibition of coagulation, and conditions of action of thrombase; its possible nucleoproteid nature; intravascular clotting. Crustacean fibrin-ferment. Myosin-ferment; comparison of myosin and fibrin; preparation of the enzyme and peculiarities of its action. Vesiculase. pp. 266—286.

## CHAPTER XVII.

THE CLOTTING ENZYMES (*continued*). PECTASE.

The formation of vegetable jellies; early work of Fremy; discovery of pectase. Researches of Mangin on the pectic bodies in plants. Work of Bertrand and Mallèvre on pectase. Preparation of the enzyme and its relation to calcium salts; conditions of the action of pectase; its distribution in the vegetable kingdom; differences in the composition of the cell-wall; formation of the middle lamella. pp. 287—300.

## CHAPTER XVIII.

AMMONIACAL FERMENTATION. *UREASE*.

Changes which take place in urine on standing. Organisms causing ammoniacal fermentation. Decomposition of urea and of hippuric acid. Urease; its detection; experiments of Musculus; of Lea; of Miguel. Conditions of activity of urease. Histozyeme. pp. 301—307.

## CHAPTER XIX.

## OXIDASES, OR OXIDISING ENZYMES.

Changes set up by oxidases. Laccase: discovery by Yoshida; preparation; action on urushic acid; work of Bertrand; action of laccase on various phenols; distribution of laccase; association with manganese; laccase in fungi. Tyrosinase; occurrence in fungi; action on tyrosin; separation of tyrosinase from laccase; its action on various aromatic compounds. Cœnoxydase: the breaking of wines due to it; presence of cœnoxydase in fruits; condition of the action of cœnoxydase. Oxidase of cider-apple. Other vegetable oxidases; presence in yeasts, plants yielding indigo, olives, aconite and belladonna, bran, &c. Animal oxidases; glycolysis in blood; oxidase of the pancreas; action on salicyl-aldehyde; relation to nucleo-proteids; oxidase in molluscs. Reducing enzymes.

pp. 308—332.

## CHAPTER XX.

## ALCOHOLIC FERMENTATION.

Early researches; work of Lavoisier, Gay-Lussac, Thénard, and de Saussure. Inversion of cane-sugar before fermentation. Nature of the decomposition; formation of alcohol and carbon dioxide; formation of succinic acid and glycerine; sugars capable of undergoing fermentation. Relation of yeast to fermentation; researches of Hansen; conditions of the action of yeast. Fermentation of other carbohydrates than sugars. Koumiss. Kephir. The ginger-beer plant and other similar organisms; Koji; Arrack. Fermentation caused by other organisms. Production of alcohol by fruits and other parts of the higher plants; conditions of such production. Significance of fermentation. Discovery of zymase; method of preparation, properties and distribution of zymase.

pp. 333—362.

## CHAPTER XXI.

## THE FERMENTATIVE POWER OF PROTOPLASM.

Behaviour of protoplasm in metabolism; intracellular decompositions without enzymes; modifications caused by absence of oxygen. Lactic fermentation and the microbes causing it. Butyric, propionic, citric and oxalic fermentations. The formation of acetic acid from alcohol: discussion as to its cause; views of Liebig, Pasteur, and later writers. The organisms causing acetic fermentation. Nitric fermentation; organisms producing nitrous and nitric acids; researches of Winogradsky. Viscous fermentation. Putrefaction; its complex character; nature of the decompositions taking place; organisms concerned: ptomaines. Relationship between organised and unorganised ferments. Views of Naegeli and Sachs.

pp. 363—395.

## CONTENTS.

xv

## CHAPTER XXII.

## THE SECRETION OF ENZYMES.

Conditions antecedent to secretion; nature of stimuli causing its occurrence; process of secretion in animal cells; sequence of changes which may be observed; process in vegetable tissues. Zymogens. Part played by the nucleus in the act of secretion; work of Macallum; formation of enzyme a gradual process; relation between zymogens and enzymes. Zymogens of pepsin, trypsin, rennet, diastase. Vegetable zymogens. The zymogen of thrombase. Differences in behaviour between zymogens and enzymes. pp. 396—417.

## CHAPTER XXIII.

## THE CONSTITUTION OF ENZYMES.

Reactions of enzymes; fallacious character of colour tests; association of enzymes with various proteids; relation existing between the proteid and the enzyme. Are enzymes proteids? Difficulties in the way of accepting this view. Study of invertase by O'Sullivan and Tompson. Theory of the nucleo-proteid constitution of enzymes; work of Pikelharing, Macallum, Spitzer. pp. 418—435.

## CHAPTER XXIV.

## THE MODE OF ACTION OF ENZYMES.

## THEORIES OF FERMENTATION.

Early theories of fermentation. Views of Valentinus, Libavius, Lemery, Willis and Stahl, Gay-Lussac. Discoveries of de Latour and his contemporaries; the vitalistic theory. Controversy between the supporters of the physical and the vitalistic theories. Views of Liebig, Pasteur, and Naegeli. Discovery of enzymes. Differences supposed to exist between their action and that of organised ferments. Views of Naegeli and Sachs. Fallacies underlying such supposed differences. Relation of fermentation to metabolism. Modern theories of fermentation. Researches of Fischer and the configuration hypothesis; theory of electric hydrolysis; theory of de Jager and Maurice Arthus; chemical hypothesis of Bunsen and Hüfner; researches of Croft Hill and their support of this theory. Destruction of enzymes by heat. pp. 436—462.

BIBLIOGRAPHY.

pp. 463—504.

INDEX.

pp. 505—512.

Cambridge University Press

978-1-107-67395-3 - The Soluble Ferments and Fermentation: Second Edition

J. Reynolds Green

Frontmatter

[More information](#)

## ERRATA.

On p. 149, line 21	<i>for</i> 4 cm.	<i>read</i> excess
p. 212, „ 26	} „ amides	„ amido-acids
p. 302, „ 25		
p. 233, „ 35	} „ casein	„ caseinogen
p. 341, „ 23		
p. 342, „ 16		
p. 245, „ 33	„ two years later	„ in 1891
p. 268, „ 30	„ tyrein	„ casein
p. 427, „ 12	„ page 177	„ page 187