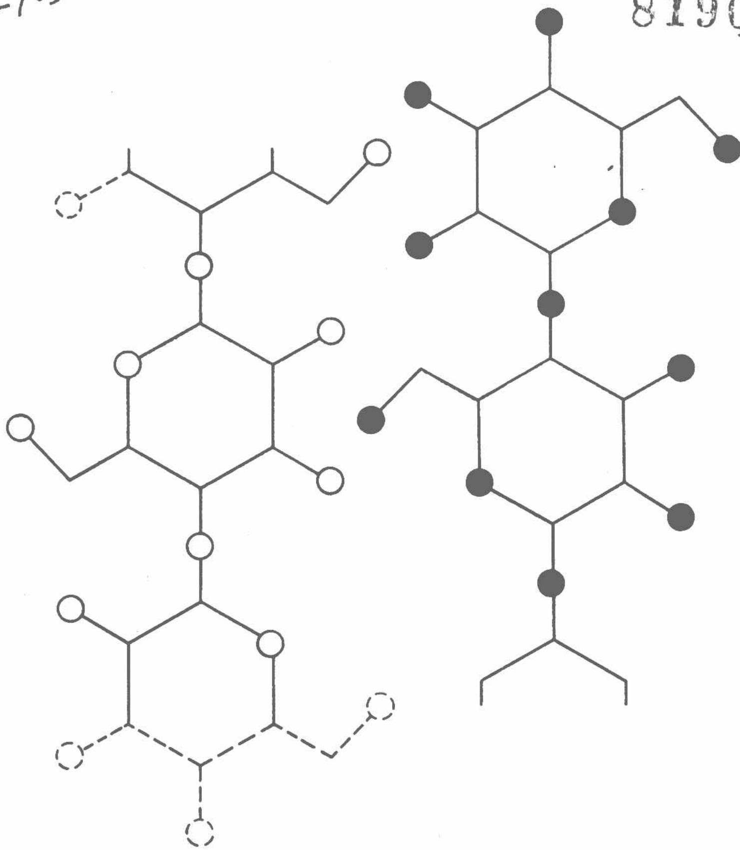

# of PLANTS and ANIMALS

AN INTRODUCTION

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Biochemistry of Plants and Animals

Wiley Eastern University Edition

BIOCHEMISTRY

M. FRANK MALLETTE
Associate Professor of Agricultural and Biological Chemistry

PAUL M. ALTHOUSE
Professor of Agricultural and Biological Chemistry

CARL O. CLAGETT
Professor of Agricultural and Biological Chemistry

Department of Agricultural and Biological Chemistry,
The Pennsylvania State University

To Our Wives

RUTH, VIRGINIA, and MARY

Preface

In common with many other fields of study, biochemistry has expanded rapidly in the last decade. Still more recently there has been a general trend to both more intensive and more widespread collegiate training in science. Therefore, our knowledge of biochemistry and our concept of what phases should be taught have changed markedly. All participants in this "revolution" agree that change will continue and will probably accelerate.

Although this book is essentially new, it originated from *Introduction to Agricultural Biochemistry* by Dutcher, Jensen, and Althouse, published in 1951. In turn this latter book derived from another of the same name by Dutcher and Haley (1932). We are deeply indebted to these earlier authors for the inspiration and guidance they have given us.

We have rewritten the text completely, endeavoring to broaden the coverage of underlying basic information, to raise the level in keeping with the better backgrounds of students now entering the subject, and to describe briefly some of the great advances being made in the field. At the same time a textbook must be relatively short, requiring a compromise on coverage. Therefore, we have sharply restricted the material on the historical development of biochemistry and the discussion of soils. Insufficient space also has prevented consideration of farm chemurgy and pesticides.

The book is divided into three major sections, devoted to general biochemistry, plant biochemistry, and animal biochemistry. Individual chapters are placed in these sections according to the orientation given the material. It is obvious that any such classification is arbitrary in specific cases. In the interests of brevity we have attempted to make suitable textual reference to appropriate sections rather than redevelop the subject in the additional context.

Basic training in inorganic and organic chemistry is assumed in students using this book. Although it is intended to provide a general knowledge of biochemistry for students in the agricultural sciences, an effort has been made to orient the treatment broadly enough for elementary courses intended for students from other disciplines. As is customary in textbooks, most chapters are relatively complete units permitting omissions in conformance with the lengths and needs of particular courses.

We are indebted to Anita Zellers and Janet Powlus for typing the manuscript.

M. Frank Mallette
Paul M. Althouse
Carl O. Clagett

University Park, Pennsylvania
May, 1960

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GENERAL BIOCHEMISTRY

part 1

The development of agricultural chemistry

1

When we attempt to study the factors that have played important roles in the development of scientific agriculture, we find that chemistry has occupied a most prominent place. The part that chemistry has played in this development has been of such far-reaching importance that a special branch of this science, known as agricultural chemistry, has been a natural outgrowth. It is to this particular phase of chemistry that we wish to direct the reader's attention, for agricultural chemistry, probably more than any other single factor, has been responsible for the development of the quantitative aspects of modern agricultural practice and for the elimination of the old "rule-of-thumb" methods which had been followed for centuries.

BEGINNINGS OF AGRICULTURAL SCIENCE

Nearly all the early workers who were interested in solving nature's secrets as they relate to agriculture were trying to discover "the principle of vegetation." They were seeking to answer the question, "Why and by what method do plants grow and develop?" One of the first theories which aimed to explain the secret of plant growth was that advanced by a Belgian physician and alchemist by the name of van Helmont. Working in the latter part of the sixteenth and the early part of the seventeenth centuries, he was among the first to introduce the use of the balance and to interpret data from the quantitative standpoint. It should be remembered that water was one of the recognized chemical elements at the time of van Helmont's work, and as a result of his studies he concluded that water must be the "principle of vegetation," citing the following experiment as proof of his theory that water could be transformed into plant tissue:

> I took an earthen vessel in which I put 200 pounds of soil, dried it in an oven, then I moistened it with rain water, and pressed hard into it a shoot of a willow weighing 5 pounds. After exactly 5 years the tree that had grown up weighed 169 pounds and about 3 ounces. But the vessel had never received anything but rain water or distilled water, to moisten the soil when this was necessary, and it remained full of soil which was tightly packed, and lest any dust from the outside should get into the soil, it was covered with a sheet of iron coated with tin, but perforated with many holes. I did not take the weight of the leaves that fell in the autumn. In the end I dried the soil once more and got the same 200 pounds that I started with, less about 2 ounces. Therefore, the 164 pounds of wood, bark, and roots arose from the water alone.

This experiment is thoroughly typical of much of the early investigational work in agricultural chemistry, as well as of other sciences. In this, as in other branches of science, it is very easy to fail to consider a vital factor and, as a result, to draw from perfectly good experiments a conclusion which appears to be correct but which is in reality entirely wrong. In the work cited above, van Helmont failed to take into consideration two most important factors, namely, the role played by the constituents of the atmosphere, and the small amount of soil which had disappeared.

Some years after van Helmont reported his result, Glauber proposed the hypothesis that saltpeter is really the "principle of vegetation." This conclusion was reached by Glauber because he secured such large increases in the yield of crops by applying this material as a fertilizer. For many years his view was widely accepted by agricultural writers. The only prominent opponent was Jethro Tull, who believed that the fineness of the soil particles had a beneficial influence on plant growth. According to this latter view, it was "the very minute particles of soil loosened by the action of moisture that constituted the proper 'pabulum' of plants. The pressure caused by the swelling of the growing roots forced these particles into the lacteal mouths of roots where they entered the circulatory system. All plants live on these particles, that is, on the same kind of food." Various other ideas regarding the "principle of vegetation" were proposed. The general view held at the close of this period cannot be better summed up than in Tull's own words: "It is agreed that all the following materials contribute in some manner to the increase of plants, but it is disputed