

# ANIMAL NUTRITION

A stylized illustration of a digestive tract, likely a rumen, shown in cross-section. The interior is dark blue and contains various nutrients and enzymes represented by different symbols: red starburst shapes, small red circles, and red lines with dots. The rumen wall is depicted with several red, cylindrical structures. The background is a solid red color.

ARON A. BONDI

# ANIMAL NUTRITION

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**ANIMAL  
NUTRITION**

This book is dedicated to the memory of our late beloved son Dr. Elchanan Esra Bondi, who devoted his main interests to the natural sciences. In 1971 he succumbed at the age of 32 to severe illness.

## *Preface*

The main purpose of animal production is to supply high-quality food for humans. Although animal products are not essential dietary components for humans other than the very young, meat, milk, cheese and eggs are very satisfying to the palate as well as providing satiety. However, animal proteins are of higher nutritional quality than plant proteins because they contain large amounts of the essential amino acids required by man. Also, animal products supply vitamins, particularly B<sub>12</sub>, and valuable minerals. Livestock production is vital to man today and will be equally important to us in the future. The consumption of animal proteins by the affluent population of the USA is very high and provides almost 70% of the protein consumed, whereas the world population obtains only one-third of the dietary protein from animal sources. Increase of the world population and rise in the standard of living will bring about an increased demand for animal proteins.

In the economics of animal production, the cost of feedstuffs is an item of greatest importance. World economy strives to reduce the losses incurred in the transformation of feedstuffs, mostly from vegetable origin, to animal products. Success of the animal enterprises depends primarily on the proper utilization of the nutrients offered. Progress in animal nutrition has been achieved mainly by discovering the metabolic processes underlying the utilization of all the nutrients which benefit the animal. In writing this text-book, attention has been focused on those biochemical aspects of nutrition that have been consolidated by recent research. Moreover, the area of bioenergetics has received quite intensive treatment, since the provision of energy is the main reason for the food supply to farm animals.

The book presents the principles of nutrition of various species of farm animals such as cattle, sheep, goats, horses, pigs and poultry. The comparative consideration of the metabolic processes occurring in various species of animals will contribute to a better understanding of the general mode of utilization of nutrients by various species and this will be profitable even for

readers interested in the nutrition of one particular species. It is not the purpose of this book to provide instructions for practical livestock feeding or descriptions of feeding stuffs. Data on nutrient requirements of the various species are not given here, since they are frequently subjected to changes according to accruing new experimental results; also, the recommended requirements are easily accessible in the currently appearing official publications of the ARC (Agricultural Research Council in Great Britain) and the NRC (National Research Council in USA).

This book is based on my textbook of animal nutrition that has been published in Hebrew in 1982 by the Magnes Press, Hebrew University, Jerusalem, Israel. The English edition has been thoroughly revised and updated. Some data on the nutrition of pigs not dealt with in the Hebrew book, have been included here.

Citations of relevant books, monographs, review articles and a limited number of significant research papers are given at the end of each chapter and a list of relevant textbooks at the end of the book.

In general, the book is designed for undergraduate and graduate students in agriculture and in veterinary sciences. It can also serve breeders and agricultural advisers with a background in chemistry, biochemistry, human nutritionists, medical scientists and physicians. The basic principles of human and animal nutrition are the same, therefore the nutrient needs of humans are occasionally compared to those of animals throughout the text.

It is my pleasure to extend sincere thanks to my colleagues who have helped in the preparation of this book. Dr David Drori has collaborated in diverse chapters. The following colleagues have collaborated in chapters dealing with fields of their particular interest as indicated in the text or assisted by reading and commenting on several sections of the book: Drs E. Alumot (Mrs), A. Arieli, I. Ascarelli, A. Bar, R. Braude (Reading, England), P. Budowski, Y. Folman, D. Levi, H. Neumark (late), I. Nir, Z. Nitsan (Mrs), B. Robinson and D. Sklan. Mrs N. Gestetner is thanked for drawing most of the figures and Mrs E. Abraham for preparing the photographs. Above all, I thank my wife, Eva, for her support, apart from many arduous hours of typing, patience and devotion, for my work.

A. BONDI.

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**Part I**

FATE AND FUNCTION OF NUTRIENTS  
IN THE ANIMAL BODY





## CHAPTER 1

# *Chemical Composition of Feedstuffs and Animals*

### INTRODUCTION

Man and animals require permanent food intake in order to permit normal functioning of the life processes. The food of farm animals consists mainly of plants and plant products. Solar energy enables plants to synthesize their components—substances of complex chemical structure, proteins, fats and carbohydrates—from simple substances such as carbon dioxide from the air, and water and inorganic substances from the soil. Considerable amounts of energy originating from solar radiation are stored as chemical energy within the plant components. When animals ingest food of plant origin, the energy contained therein is used by the animals for maintaining bodily functions (respiration, blood flow and nervous system function), for tissue gain in growing animals and for formation of animal products (milk, eggs, wool, etc.).

Water is the quantitatively predominant constituent of the animal body, surpassing the total amount of all other constituents. The bulk of the dry matter in animals and plants is made up mainly of three groups of organic compounds—proteins, fats and carbohydrates—and also of inorganic matter (minerals) and some minor constituents such as vitamins, nucleic acids and others. However, there are striking differences between plants and animals in the composition and quantitative relationship of the three groups of organic compounds. The dry matter of plants consists principally of carbohydrates (75–80%); the animal body contains only about 1%, even though in the animal carbohydrates fulfil vital functions in energy production. It should be