

# NONRUMINANT NUTRITION HANDBOOK

## *Seventh Revision*

Copyright © 2004 by Lee I. Chiba

All rights reserved.

Permission is granted to photocopy this handbook for personal use  
with an appropriate acknowledgement of the author.

---

---

### Contents

#### **Section 1: Introduction and Digestive**

*Physiology* ..... 1 - 27

Role of the Pig? ..... 1

The Pig as a Model for Human Research ..... 3

Pigs, Poultry, and Horses ..... 4

Digestive Systems - From Feed Detection to

Esophagus ..... 5

The Stomach ..... 10

The Intestinal System ..... 14

Liver and Pancreas ..... 18

Gastrointestinal Hormones ..... 22

The pH and Digestive Process ..... 24

Baby Pigs and Digestive Enzymes ..... 26

Food for Thought ..... 27

#### **Section 2: Water and Electrolytes**

*(& Iodine)* ..... 28 - 48

Water ..... 28

Electrolytes in General ..... 35

Sodium and Chlorine (Salt) ..... 36

Potassium ..... 39

Iodine ..... 42

Electrolyte Balance ..... 43

Electrolytes and Iodine for Fish ..... 46

#### **Section 3: Carbohydrates** ..... 49 - 67

Introduction ..... 49

Nutritionally Important Sugars/CH<sub>2</sub>O ..... 50

Digestion .....	54		
Absorption .....	58		
Metabolism .....	59		
Dietary Fiber .....	63		
Processing of Grains & Diets .....	66		
Palatability .....	67		
<b>Section 4: Lipid Metabolism and Vitamins/</b>			
<b>Mineral</b> .....	68 - 111		
Introduction .....	68		
Essential Fatty Acids .....	69		
Fatty Acids and Human Health .....	73		
Digestion and Absorption .....	75		
Metabolism .....	78		
Brown Adipose Tissue .....	80		
Vitamin E and Selenium Interrelationships ..	81		
Vitamin E .....	83		
Vitamin E and Human Health .....	87		
Selenium .....	89		
Choline .....	94		
Supplemental Dietary Lipids .....	99		
Feed Grade Lipids .....	108		
<b>Section 5: Protein Metabolism and Vitamins/</b>			
<b>Minerals</b> .....	112 - 167		
Protein in General .....	112		
Protein and Amino Acids .....	114		
Protein Digestion .....	118		
Absorption of Amino Acids and Peptides ...	125		
Protein Metabolism in General .....	129		
Protein Synthesis and Turnover .....	130		
Amino Acid as a Source of Energy .....	132		
Transamination and Deamination .....	133		
Vitamin B <sub>6</sub> .....	134		
D-Isomers, $\alpha$ -Keto and $\alpha$ -Hydroxy Analogs .	136		
Excretion of Nitrogen .....	137		
Special Functions of Amino Acids .....	138		
Folacin, Vitamin B <sub>12</sub> and Cobalt (& Sulfur) .	140		
Essentiality of Amino Acids .....	145		
Amino Acid Disproportion .....	147		
Protein Quality .....	150		
Protein and(or) Amino Acid Requirements ..	151		
Ideal Protein .....	157		
Amino Acids and Energy .....	160		
Amino Acids and Environment .....	163		
Gender/Type of Animals and Amino Acid			
Requirements (e.g., Pigs) .....	164		
Repartitioning Agents and Amino Acids ...	165		
Crystalline Amino Acids .....	166		
<b>Section 6: Energy Metabolism and</b>			
<b>Vitamins</b> .....	168 - 193		
Energy Systems .....	168		
Energy Requirement .....	170		
Growing Animals and Energy (e.g., Pigs) ..	173		
Breeding Animals and Energy (e.g., Swine) .	176		
Vitamins in General .....	178		
Thiamin (Vitamin B <sub>1</sub> ) .....	181		
Riboflavin (Vitamin B <sub>2</sub> ) .....	184		
Niacin .....	186		
Pantothenic Acid .....	189		
Biotin .....	190		
<b>Section 7: Bone and Vitamins/Minerals</b> 194 - 238			
Bone in General .....	194		
Minerals in General .....	198		
Calcium and Phosphorus .....	208		
Other Minerals in Bone Physiology .....	218		
Magnesium .....	219		
Manganese .....	221		
Zinc .....	223		
Fluorine .....	225		
Vitamin D .....	227		
Vitamin A .....	230		
Vitamin C .....	235		
<b>Section 8: Circulation and Vitamin/</b>			
<b>Minerals</b> .....	239 - 248		
Vitamin K .....	239		
Iron .....	241		
Copper .....	245		
<b>Major References</b> .....			
249- 251			

## A Tribute to the Stockman

*Behold the Stockman!  
Artist and Artisan, he may be polished,  
or a diamond in the rough . . .  
but always a Gem.*

*Whose devotion to his animals is  
second only to his love of God and family,  
whose gripping affection is  
tempered only by his inborn sense of  
the true proportion of things,  
who cheerfully braves  
personal discomfort to make sure  
his live stock suffer not!*



*To him,  
there is rhythm in the clatter of the horse's hoof,  
music in the bleating of the sheep and the lowing of the herd.*

*His approaching footsteps call forth the whinny of recognition.  
His calm, well-modulated voice  
inspires confidence and wins affection.  
His coming is greeted with demonstrations of pleasure,  
and his going with evident disappointment.*

*Who sees something more in cows than the drudgery of milking,  
more in swine than the grunt and squeal,  
more in the horse than the patient servant,  
and more in sheep than the golden hoof.*

*Herdsmen, shepherd, groom . . . yes, and more!  
Broad-minded, big-hearted, whole-souled;  
whose life and character linger long after the cordial greeting  
is stilled and the hearty handshake is but a memory;  
whose silent influence forever lives.*

*May his kind multiply and replenish the earth!*

(Herbert W. Sanford & Unknown Cartoonist)