

---

# Contents

Foreword .....	ix
Acknowledgment .....	xi
Author .....	xiii
<b>Chapter 1</b> Introduction, History, and Evolution .....	1
1.1 General Information .....	1
1.2 History of the Production and the Use of Lipids .....	2
1.3 Lipids and Human Nutrition: History and Evolution .....	3
1.4 Lipids and Health .....	6
References .....	7
<b>Chapter 2</b> Nature and Sources of the Main Lipids .....	9
2.1 Introduction .....	9
2.2 Fatty Acids .....	11
2.2.1 Saturated Fatty Acids .....	11
2.2.2 Unsaturated Fatty Acids .....	13
2.2.2.1 <i>n</i> -9 Fatty Acids .....	13
2.2.2.2 <i>n</i> -6 Fatty Acids .....	13
2.2.2.3 <i>n</i> -3 Fatty Acids .....	14
2.2.3 <i>trans</i> Fatty Acids .....	15
2.2.4 Conjugated Linoleic Acids .....	16
2.3 Triacylglycerols .....	17
2.3.1 Crop Productions .....	18
2.3.1.1 Palm Oil .....	19
2.3.1.2 Soybean Oil .....	21
2.3.1.3 Rapeseed Oil .....	22
2.3.1.4 Sunflower Oil .....	23
2.3.1.5 Cottonseed Oil .....	24
2.3.1.6 Palm Kernel Oil .....	25
2.3.1.7 Peanut Oil .....	26
2.3.1.8 Olive Oil .....	26
2.3.1.9 Coconut Oil .....	27
2.3.1.10 Corn Oil .....	28
2.3.1.11 Sesame Oil .....	29
2.3.1.12 Linseed Oil .....	29
2.3.1.13 Processed Products: Margarines .....	30
2.3.2 Livestock Productions .....	32
2.3.2.1 Tallow .....	32
2.3.2.2 Lard .....	33
2.3.2.3 Butter .....	33

2.3.2.4	Fish Oils.....	36
2.3.2.5	Meat-Included Fats .....	37
2.4	Phospholipids.....	39
2.5	Glycolipids.....	41
2.6	Cholesterol and Phytosterols .....	42
2.7	Liposoluble Vitamins .....	43
2.7.1	Vitamin A and Carotenoids .....	43
2.7.1.1	Vitamin A .....	43
2.7.1.2	$\beta$ -Carotene .....	44
2.7.1.3	Lutein and Zeaxanthin.....	44
2.7.1.4	Astaxanthin.....	45
2.7.1.5	Lycopene .....	45
2.7.2	Vitamin D.....	45
2.7.3	Vitamin E.....	47
2.7.4	Vitamin K.....	48
2.8	Lipid Substitutes .....	49
2.8.1	Low-Energy Lipids.....	49
2.8.1.1	Structured Triglycerides .....	49
2.8.1.2	Nondigestible Glycolipids.....	50
2.8.2	Diacylglycerols.....	50
	References .....	51

<b>Chapter 3</b>	<b>Lipids and Human Nutrition .....</b>	<b>53</b>
3.1	Introduction .....	53
3.1.1	History.....	53
3.1.2	Total Energy Requirements.....	54
3.1.3	Nature of Dietary Lipid Intakes .....	56
3.2	Metabolism and Dietary Requirements.....	59
3.2.1	Triacylglycerols and Nutrition.....	62
3.2.1.1	Absorption: Digestion.....	62
3.2.1.2	Blood Transport .....	63
3.2.1.3	Dietary Intakes of Lipids and Fatty Acids ....	65
3.2.1.4	Importance of the Triacylglycerol Structure .....	106
3.2.2	<i>trans</i> and Conjugated Fatty Acids .....	108
3.2.2.1	<i>trans</i> Fatty Acids .....	109
3.2.2.2	Conjugated Fatty Acids.....	112
3.2.3	Cholesterol and Phytosterols .....	114
3.2.3.1	Cholesterol .....	114
3.2.3.2	Phytosterols.....	115
3.2.4	Fat-Soluble Vitamins and Related Compounds .....	119
3.2.4.1	Vitamin A and Carotenoids .....	120
3.2.4.2	Vitamin D .....	127
3.2.4.3	Vitamin E.....	138
3.2.4.4	Vitamin K.....	143

3.2.5	Phospholipids .....	147
3.2.5.1	Phosphatidylcholine .....	147
3.2.5.2	Sphingomyelin .....	151
3.2.5.3	Phosphatidylserine .....	152
3.2.6	Glycolipids.....	153
3.2.6.1	Glycolipids Dietary Intake.....	154
3.2.6.2	Glycolipid Food Sources.....	154
3.2.6.3	Dietary Supplements.....	155
	References .....	155
<b>Chapter 4</b>	<b>Lipids and Health .....</b>	<b>161</b>
4.1	Introduction: Importance of Lipid Intake.....	161
4.2	Fatty Acids and Health .....	163
4.2.1	Saturated Fatty Acids .....	163
4.2.1.1	Long-Chain Saturated Fatty Acids .....	164
4.2.1.2	Short-Chain and Medium-Chain Fatty Acids .....	172
4.2.1.3	Branched-Chain Fatty Acids .....	174
4.2.2	<i>n</i> -9 Fatty Acids .....	175
4.2.2.1	Cardiovascular Disease .....	175
4.2.2.2	Cancers .....	177
4.2.3	<i>n</i> -6 Fatty Acids .....	178
4.2.3.1	Cardiovascular Disease .....	179
4.2.3.2	Cancers .....	180
4.2.3.3	<i>n</i> -6 to <i>n</i> -3 Fatty Acid Ratio .....	181
4.2.4	<i>n</i> -3 Fatty Acids .....	183
4.2.4.1	Cardiovascular Disease .....	184
4.2.4.2	Inflammatory and Immune Diseases.....	192
4.2.4.3	Metabolic Diseases .....	195
4.2.4.4	Cancers .....	197
4.2.4.5	Nervous Diseases.....	202
4.2.5	<i>trans</i> and Conjugated Fatty Acids.....	228
4.2.5.1	<i>trans</i> Fatty Acids .....	228
4.2.5.2	Conjugated Fatty Acids.....	232
4.2.6	Influence of the Structure of Triacylglycerols.....	235
4.3	Sterols and Health.....	236
4.3.1	Cholesterol.....	236
4.3.1.1	Cardiovascular Diseases .....	236
4.3.1.2	Nervous Diseases.....	239
4.3.1.3	Cancers .....	240
4.3.2	Phytosterols .....	241
4.4	Vitamins and Health.....	242
4.4.1	Vitamin A and Carotenoids .....	243
4.4.1.1	Vision .....	243
4.4.1.2	Immune System and Infections .....	246

4.4.1.3	Skin.....	248
4.4.1.4	Cancers .....	249
4.4.1.5	Cardiovascular System .....	251
4.4.1.6	Alzheimer's Disease .....	253
4.4.2	Vitamin D.....	254
4.4.2.1	Phosphocalcic Metabolism .....	255
4.4.2.2	Metabolic Diseases .....	256
4.4.2.3	Cardiovascular Diseases.....	258
4.4.2.4	Cancers .....	260
4.4.2.5	Nervous Diseases.....	263
4.4.2.6	Immunity .....	267
4.4.3	Vitamin E .....	272
4.4.3.1	Cardiovascular Diseases.....	272
4.4.3.2	Biosynthesis of Cholesterol .....	273
4.4.3.3	Cancers .....	273
4.4.3.4	Nervous Diseases.....	274
4.4.3.5	Immune System Disorders.....	277
4.4.3.6	Reproduction.....	277
4.4.4	Vitamin K.....	278
4.4.4.1	Blood Coagulation .....	278
4.4.4.2	Calcification (Bones and Arteries) .....	279
4.4.4.3	Nervous Diseases.....	281
4.5	Phospholipids.....	282
4.5.1	Phosphatidylcholine .....	282
4.5.1.1	Cardiovascular Disease .....	282
4.5.1.2	Nervous Diseases.....	283
4.5.1.3	Liver Diseases.....	283
4.5.1.4	Physical Performances.....	284
4.5.2	Phosphatidylserine.....	284
4.5.2.1	Nervous Diseases.....	285
4.5.2.2	Physical Performance .....	286
4.6	Sphingolipids .....	287
4.6.1	Nervous Diseases .....	287
4.6.2	Intestinal Diseases.....	289
4.6.3	Cancers .....	290
4.6.4	Biosynthesis of Cholesterol .....	291
4.7	Replacement Lipids .....	291
4.7.1	Hypoenergetic Fats.....	292
4.7.1.1	Structured Triacylglycerols.....	292
4.7.1.2	Glycolipids .....	293
4.7.2	Diacylglycerols .....	293
	References .....	294
	<b>Abbreviations .....</b>	<b>303</b>
	<b>Index.....</b>	<b>307</b>