

Contents

<i>Chapter 1</i>	
The Definition of Brewing	1
The Origins of Brewing	1
Louis Pasteur (1822–1895)	6
Antonj van Leewenhoek (1632–1723)	8
Robert Boyle (1627–1691)	9
Chemists and the Brewing Industry	9
The Carlsberg Laboratory	12
Some Important British Brewing Institutions	13
The Bacterium Club	13
The Institute of Brewing	13
The Brewers’ Guild	14
Brewing Research International	14
The Brewers’ Society	14
References	14
<i>Chapter 2</i>	
Malting	15
The Barley Plant	17
The Malting Process	22
Biochemical Structure of Barley	23
Starchy Polysaccharides	24
Non-starchy polysaccharides	24
Proteins (Nitrogen)	25
Lipids	26
Other Constituents	26

Main Events during Malting	26
Kilning	27
Malting Loss	28
Specification of Malt	29
Milling and Mashing	29
Milling	30
Mashing	31
Mash Separation	38
Mash Filters	41
Characteristics of Sweet Wort	45
Carbohydrate Composition	45
Nitrogen Compounds	46
Fatty Acids	47
Sulfur Compounds	47
Other Cereals used in Brewing	48
Wheat	48
Rice	48
Oats	49
Rye	49
Maize	49
Triticale	49
Sorghum	50
Adjuncts	51
Coloured Malts	52
Commercial Enzymes used in Brewing	54
References	57
Chapter 3	
Hops	58
The Plant	59
Processing	64
Hop Products	65
Hop Varieties	68
Dwarf Hops	71
Hop Constituents	71
Hop Diseases	81
Verticillium Wilt	81
Downy Mildew	81
Powdery Mildew	82
Red Spider Mite	82

<i>Contents</i>	ix
Damson Hop Aphid	82
Viruses	83
References	84
<i>Chapter 4</i> Wort Boiling and Cooling	85
Wort Boiling	85
Wort Cooling	95
References	98
<i>Chapter 5</i> Fermentation	99
The Yeast	99
The Nutritional Requirements of Yeast	106
Carbon Metabolism	107
Nitrogen Metabolism	107
Vitamins	108
Inorganic Ions (Other Elements)	108
Oxygen	112
Yeast: Physiological Condition and Vitality	113
Fermentation	115
Storage Compounds	126
Fermentation Systems	127
New Brewing Yeasts	133
References	138
<i>Chapter 6</i> Beer – Post-fermentation	139
Cask-conditioned Beer	141
Casks	142
Fining	148
Dispensing of Cask-conditioned Beer	150
Brewery-conditioned Beer	159
Kegging	164
Small Pack	166
Nitrogenated Beers	171
High-gravity Brewing	172

Low Alcohol Beers (NABLABs)	175
Ice Beer	180
Wheat Beers	181
Gravity and Beer Strength	182
Bitterness	184
Colour	184
Foam	186
Nitrosamines	188
Beer Flavour	191
References	193
<i>Chapter 7</i>	
Microbiology in the Brewing	194
ATP Bioluminescence	197
The Polymerase Chain Reaction (PCR)	198
Bacteria	199
Enterobacteriaceae	201
<i>Obesumbacterium proteus</i>	203
<i>Zymomonas mobilis</i>	204
Acetic Acid Bacteria	206
<i>Pectinatus cerevisiiphilus</i>	207
<i>Megasphaera cerevisiae</i>	208
Lactic Acid Bacteria	209
<i>Bacillus</i> spp.	213
Wild Yeasts	213
Spontaneous Fermentations	217
Lambic Fermentation	217
References	223
Subject Index	224