

INDEX

A

- Acceptor molecules, effect on
 - transgalactosylase activity, 76–79
- Activation
 - energy, 204–205
 - lactase, 41
 - transgalactosylase activity of lactases, 82–83
- Agglomeration, 209–210
- Aglycones, specificity of transgalactosylase reaction, 81
- Algin, immobilization of lactases, 43
- Allolactose
 - production
 - K. lactis* β -galactosidase velocity, 65, 70
 - potassium and magnesium effects, 82
 - in yogurts, 84
- Antiplasticization, by sugars, 156–159
- Arrhenius behavior, compared to WLF behavior, 188–200
- Arrhenius equation, explicit reference temperature, 207
- Arrhenius kinetics, contrast with WLF kinetics, 204–212
- Arrhenius plots, 205–206
- Arrhenius relaxation behavior, 193
- Aspergillus fonsecaeus*, lactase, 59
- Aspergillus niger*
 - lactase, potential application in HTST pasteurization of milk, 89
 - product inhibition, 9–10
 - saccharide production and temperature, 70–71
 - transgalactosylase products, 79–80
- Aspergillus oryzae*
 - immobilized enzyme system, column reactor using, 47, 49

- lactase, temperature effects, 34–35
- saccharide production and temperature, 70–71
- transgalactosylase products, 79–80
- Assay methods, transgalactosylase activity, 64–69
- Axial-annular flow reactor, 45–46

B

- Bacillus circulans*, β -galactosidase from, 86, 89
- Bacillus stearothermophilus*, lactase, 58
- Bifidobacterium*, growth promoters, 85

C

- Caking, 209–210
- Calcium, intake, milk avoidance and, 4
- Carbohydrates, low-molecular-weight
 - C_g' values, 167–168
 - disparity, 229
 - glass transition temperature, 148–149
 - solute-specific subzero glass transition temperature, 139
- Carbohydrate–water systems, kinetically metastable, WLF behavior, 189
- Caseinate, 37
- Continuous stirred tank reactors, lactase immobilization, 18–19
- Cookies
 - absence of polymerization and glutenins and gliadins, 224
 - glass transition, 185
- Corn
 - chemical components, 271–272
 - quality protein maize, 274
 - structure, 273–278

- caryopsis, 274
- endosperm, 275–277
- enzymatic degradation, 291–292
- germ, 277–278
- protein bodies, 275, 277
- seed coat, 274–275
- steeping agent effects, 283–286
- types used, 273
- Corning process, hydrolysis of lactose, 47, 51
- Corn sweeteners, 294–295
- Corn wet milling, 271–297
 - biochemical effects, 287
 - cleaning, 278
 - industry scale, 273
 - kernel degradation, 283–286
 - laboratory versus commercial milling, 288–290
 - lactic acid role, 281–282
 - milling and final processing, 287–288
 - nonstarch by-products, 296
 - process flow, 272
 - products, derived from starch, 292–295
 - modified starches, 293–294
 - native starches, 292–293
 - using fermentation or enzymatic technologies, 294–295
 - research to improve, 290–292
 - steeping, 278–280
 - steepwater absorption, 280–281
 - sulfur dioxide role, 282–283, 285–286
 - temperature role, 286–287
- Crackers, glass transition, 185
- Cryostabilization, 162–163, 165–166
- Crystallization
 - kinetics, 210–212
 - time, WLF- versus Arrhenius-type temperature dependence, 181–182
- Curing, material states, 214

D

- Dairy industry, waste utilization, 20–22
 - Degerminating mill, 287–288
 - Disaccharides, formed by *K. lactis* lactase, 77, 79
 - Dynamics map, 129, 134, 159–177
 - C_g' values, 166–169
 - solute-specific subzero glass transition temperature, 161, 163–166
 - water and glass dynamics, 160
 - WLF equation, 160, 177–188
- ## E
- Energy, activation, 204–205
- ## F
- Food
 - amorphous powder, state diagram, temperature versus water content, 209
 - aqueous glasses, diffusion of water and solute, 169–177
 - flour-based products, viscoelasticity, 184–185
 - glass transition temperature measurement, 114–118
 - labile components, encapsulation, 171
 - nonequilibrium nature of products and processes, references, 115–117
 - patents using β -galactosidase activity for galactooligosaccharide production, 87
 - transgalactosylase activity, 84–95
 - Food molecule–water systems, characterization, 120, 124–125
 - Food polymer science, 106–143; *see also* Dynamics map; Glass transition temperature
 - evolution of approach, 109–114
 - glasses and glass transitions, 107–109
 - temperature measurement, 114–118
 - ice-melting onset transition, 164–165
 - plasticization
 - effect on glass transition temperature, 118, 120–125
 - by water, 150–159
 - state diagrams, 135–143
 - structure–property relationships, references, 107
 - thermosetting, amorphous polymers, 212–226
 - water and glass dynamics, 127, 129–135
 - Food–polymer systems, aqueous, viscoelastic behavior, 183–188
 - Fragility plot, 193
 - Freezing point, depression, oligosaccharide formation and, 30

- Fringed micelle model,
 - crystalline–amorphous structure of partially crystalline polymers, 129, 133
- Fuel alcohol, from corn wet milling, 295

G

- Galactobiose, in yogurts, 84
- Galactose
 - concentration changes and allolactose production, 83
 - effect on lactase activity during milk processing, 12
 - enzymatic modification, 10
- β -Galactosidase, *see also* Lactase
 - from *B. bifidum*, 85
 - catalysis of lactose hydrolysis, 24–25
 - hydrolysis, 23–24
 - patents using, for production of galactooligosaccharides, 87
 - purified, 23
 - specificity for lactose portions, 63
- Galactosyl, enzymatic transfer reactions, 60
- Gelatinization, sugar role, 158
- Gelation, curing reaction and, 214
- Gel point, 214
- Gidley endotherm, 172
- Glass dynamics, 133–135, 160
- Glass-forming liquids
 - behavior classification, 192–195
 - super-structuring effects, 197–198
- Glass transition, 107–109
 - definition, 108
 - ice-melting onset transition, 164–165
 - recent publication, 111–113
 - research needs, 226–233
 - studies using methods other than DSC or DMA, 115, 119–120
 - texture of cereal and, 185
- Glass transition temperature
 - diluent–monomer blend, 175–176
 - effects of water as plasticizer, 151–159
 - as function of
 - log degree of polymerization, 138, 144
 - moisture, hand-washed and lyophilized wheat gluten, 153–154
 - gluten, moisture effect, 219
 - low-molecular-weight carbohydrates, 148–149
 - measurement
 - in foods, 114–118
 - methods, 227–228
 - molecular weight effect, 138, 144–150
 - maltooligosaccharides, 144, 147
 - plasticization effect, 118, 120–125
 - polymer–polymer and
 - polymer–plasticizer blends, 145–150
 - relaxation phenomena, 195–196
 - solute-specific subzero, 136–137, 139–143, 161, 163–166
 - as function of dextrose equivalent, 144–145
 - as function of molecular weight, maltooligosaccharides, 144, 146
 - low-molecular-weight carbohydrates, 139–143
 - temperature–composition domain above, 207–208
 - temperature location, determined by free volume, 198
 - temperature–time conditions of measurement, 227
- Glassy state, recent publication, 111–113
- Gliadins, 216
 - local intermolecular disulfide crosslinking, 217, 222
 - thermolabile disulfide bonds, 225
- Glucose, concentration changes and allolactose production, 83
- Glucose oxidase, enzymatic acidification of milk by, 16
- Gluten
 - amorphous, thermosetting behavior, 218–223
 - aqueous systems, thermoplastic and thermoset behavior, 223–226
 - classification of proteins, 216
 - corn, 288, 296
 - disulfide crosslinks, no change in free–SH groups, 224
 - glassy state, 123, 126–127
 - hand-washed and lyophilized, glass transition temperature as function of moisture, 153–154
 - pathways leading to ultimate thermosets, 225–226
 - plasticization, bread-baking, 218–219
 - water-plasticized, thermosetting, 222–223

wheat, as viscoelastic polymer system,
215–218
Glutenins, 216–217
 long-range intermolecular disulfide
 network formation, 217, 222
 thermolabile disulfide bonds, 225
Glycerol, solute-specific subzero glass
 transition temperature, 228–229
Glycoside hydrolases, 23–25
Glycosyl, enzymatic transfer reactions, 60
Gordon–Taylor equation, 150

H

Hevea rubber, local viscosity, 192
Hollow-fiber enzymatic reactor, 52–53
 loaded on lumen side of membrane,
 52–54
Hydrolysis
 lactose
 chemical reactor, 45–46
 in milk, 10–12
 reverse, versus transgalactosylation,
 61–64
 whey, immobilized lactase reactors,
 46–47

I

Ice cream, lactase in, 13–15
Industrial chemicals, from corn wet milling,
295
Inhibition
 lactase, 42–43
 transgalactosylase activity of lactases,
 82–83

K

Kluyveromyces fragilis, β -galactosidase, 25,
78–79
Kluyveromyces lactis
 β -galactosidase
 hydrolysis catalyzed by, 72–73
 specificity, 81
 transgalactosylase activity and
 substrate components, 77–78
 velocity for production of allolactose,
 65, 70

lactase
 concentration effect on lactase-
 catalyzed hydrolysis, 54–55
 disaccharides and oligosaccharides
 formed by, 77, 79
 temperature requirements, 34
lactase stability
 enzyme concentration effect, 37–38
 function of protease contamination, 40
product inhibition, 9–10

L

Lactase, *see also* β -Galactosidase
 commercial
 future potential, 56–59
 properties, 30–39
 purity, 39–41
 sources, 5–6
 technical data, 32
 transgalactosylase assay conditions, 64,
 66–68
 deficiency, 3
 effect on sensory properties of nonfat ice
 milk, 14–15
 enzyme modification, 57–58
 in fermented milk, 14–17
 fungus-derived, optimum temperatures,
 33–34
 hydrolase, assay methods and enzyme
 activity
 chemically modified substrates, 27–29
 colorimetric analysis, 26–27
 hydrolysis rates, 30–31
 hydrolase activity, 22–59
 activation and inhibition, 41–43
 assay methods and, 25–31
 enzyme mechanism, 23–26
 future potential for commercial
 sources, 56–59
 immobilization mechanisms and
 reactor systems, 43–51
 ultrafiltration bioprocess reactors, 47,
 50, 52–56
 in ice cream, 13–15
 immobilization, 18–20
 commercially available technologies,
 47–48
 immobilized systems, 16, 18–20, 44
 impact of microbial source, 80

- level decrease with age, 3–4
 - linked to modified corn grits, 45
 - low-lactose milk, 6–7
 - processing by consumers, 7–9
 - powders, lactase units, 28–29
 - pressure-induced immobilization, 19
 - product inhibition, 9–13
 - protease activity, 40–41
 - research needs, 89–90
 - selection
 - pH, 33
 - stability, 35–39
 - temperature, 33–35
 - stability
 - pH change effects, 39
 - skim milk
 - enzyme concentration effect, 37–38
 - media and temperature effect, 37
 - transgalactosylase activity, 59–89
 - activation and inhibition, 82–83
 - assay methods, 64–69
 - commercial source effect, 77–80
 - compounds formed, 86, 88
 - donor plus acceptor molecules, 76–79
 - in food, 84–85
 - future sources, 86, 89
 - future utilization, 85–89
 - lactase concentration, 76
 - pH, 65, 69–70
 - potential uses, 89–90
 - specificity, 80–82
 - substrate concentration, 76–70
 - temperature and reaction time, 70–76
 - transgalactosylation versus reverse hydrolysis, 61–64
 - waste lactose utilization, 20–21
 - yeast
 - immobilization of whole cells, 45
 - stability, 35
 - Lactic acid
 - in laboratory steeping, 289–290
 - role, in corn wet milling, 281–282
 - Lactobacillus bulgaricus*, potential lactase sources, 86
 - Lactose, 37
 - concentration effect on
 - allolactose production, 65, 69–70
 - production of oligosaccharides by transgalactosidation, 74–76
 - half-life in column reaction, 47, 50
 - hydrolysis
 - catalyzed by β -galactosidase, 24–25
 - chemical reactor, 45–46
 - maximum product synthesis, 72
 - syrup production, 21–22
 - Lactose-reduced foods, 5
 - Lactulose, formation, 69
- M**
- Magnesium ions, effects on
 - β -galactosidase, 82
 - Maize, *see* Corn
 - Maltodextrins, 295
 - Maltooligosaccharides
 - C_g' values, 168–169
 - glass transition temperature as function of molecular weight, 144, 146–147
 - Michaelis–Menten equation, analogy with WLF equation, 200–204
 - Microwave, reheating of baked products, 220–221
 - Milk
 - fermented, lactase in, 14–17
 - β -galactosidase stability in, 36
 - low-lactose, 6–7
 - processing by consumers, 7–9
 - skim
 - half-life in column reaction, 47, 50
 - lactase stability
 - enzyme concentration effect, 37–38
 - media and temperature effect, 37
 - sugar, malabsorption, 2–4
 - MM equation, 202
 - Mobility
 - defined by WLF equation, 179
 - diffusional, above and below glass transition temperature, 173–174
 - water, in glassy materials, 169–170
- O**
- Oligosaccharides
 - formed by *K. lactis*, 77, 79
 - in low-lactose milk and whey products, 84–85
 - production by transgalactosidation, lactose concentration, 74–76
- P**
- pH, lactase, 65, 69–71
 - selection and, 33

- Plasticization
 effect on glass transition temperature,
 118, 120–125
 by sugars, 156–159
 by water, 150–159, 187–188
 breakfast cereals, crispness and, 185
 distinguished from presence of water,
 156–157
 unfreezability, 170
 Plasticizer, effect on curing and
 vitrification, 214
 Polyisobutylene, local viscosity, 192
 Polymer–plasticizer blends, glass transition
 temperature, 145–147, 149–150
 Polymer–polymer blends
 diffusional motion, 174–175
 glass transition temperature, 145–147,
 149–150
 Polymers
 amorphous, thermosetting, 212–226
 curing, 213–214
 wheat gluten, *see* Gluten
 crystalline melting enthalpies, 190
 glass-forming, T_m/T_g ratio, 191–192
 partially crystalline
 fringed micelle model of
 crystalline–amorphous structure,
 129, 133
 viscoelastic behavior, 183–184
 Potassium ions, effects on
 β -galactosidase, 82
 Product inhibition, lactase, 9–13
 Prolamins
 corn, 275, 277
 wheat, 216

R

- Recrystallization, 211–212
 Relaxation
 diffusion-limited, rate defined by WLF
 equation and Arrhenius equation,
 205–206
 enthalpic, 172–173
 α Relaxation, 199
 β Relaxation, 199–200
 Rotational diffusion, 196–197

S

- Salt, effect on β -galactosidase stability, 36
 Shortening, effect on four–water bread
 doughs, 220

- Solute, diffusion in aqueous food glasses,
 169–177
 Stability, β -galactosidase, 35–39
 Starch
 acid-modified, 294
 crosslinked, 293
 gelatinization and retrogradation studies,
 123, 128–129
 glassy state, 123, 126–127
 modified, products from, 293–294
 native, products from, 292–293
 stabilized, 293
 Starch–water system, gelatinized, glass
 transition temperature as function of
 mass fraction, 152–153
 State diagrams, 135–143
 glass transition temperature
 as function of mass fraction, 152–153
 location, 199
 references, 137–138
 Steeping, corn, 278–280
 Steepwater, absorption by corn, 280–281
Streptococcus thermophilus
 lactase, 58
 potential lactase sources, 86
 Sucrose, synthesis, lactase usage, 22
 Sugar
 aqueous solutions, viscosity temperature
 dependence, 180–181
 effect on β -galactosidase stability, 36
 malabsorption, 2–4
 plasticization and antiplasticization by,
 156–159
 Sulfur dioxide
 in laboratory steeping, 289
 role in corn wet milling, 282–283,
 285–286

T

- Temperature
 lactase selection and, 33–35
 reaction time and, lactase, 70–76
 role in corn wet milling, 286–287
 Thermosetting, amorphous polymers,
 212–226
 Time–temperature scaling parameter, WLF
 plots, 189–190
 Time–temperature transformation reaction
 diagram, 212–213
 Transgalactosylase activity, *see* Lactase

Transgalactosylation, versus reverse hydrolysis, 61–64
Translational diffusion, 196–197
Trehalose, C_g' value, 168

U

Ultrafiltration
 bioprocess reactors, lactose hydrolysis, 47, 50, 52–56
 enzyme bioreactor, modified localized, 52, 54
 lactase immobilization, 18–20

V

Viscosity
 as function of reduced temperature for glassy and partially crystalline polymers, 108–109
 local, 198
 temperature dependence, aqueous solutions, 180–181
Vogel–Tammann–Fulcher equation, 194

W

Water
 as crystallizing plasticizer, 161
 diffusion in aqueous food glasses, 169–177
 mobility, in glassy materials, 169–170
 as plasticizer, 150–159
 breakfast cereals, crispness and, 185
 distinguished from presence of water, 156–157
 food and biological materials, 120–123
 independent mechanical aspect, 187–188
 mechanical relaxation kinetics, 186–187
 unfreezability, 170
Water activity concept, 229–230
Water dynamics, 127, 129–133, 160

Water–food structure interactions, 103–233;
 see also Food polymer science; Glass transition temperature studies, 104–105

Whey

β -galactosidase stability in, 36
 half-life in column reaction, 47, 50
 hydrolysis, immobilized lactase reactors, 46–47

 lactose syrup production, 21–22
 waste utilization, 20–21

Williams–Landel–Ferry free-volume theory, 135, 177

WLF behavior

 compared to Arrhenius behavior, 188–200
 effect on kinetics of diffusion-limited relaxation processes, 208–209
 relaxation times, 189–191

WLF coefficients, intuitive implications, 200

WLF equation, 160, 177–188

 analogy with Michaelis–Menten equation, 200–204

 application, 178, 230

 aqueous food–polymer systems, viscoelastic behavior, 183–188

 correct glass transition temperature reference state, 230–231

 crystallization kinetics, 181–182, 210–212
 explicit reference temperature, 207

 mobility definition, 179

WLF kinetics, 135, 176

 contrast with Arrhenius kinetics, 204–212

WLF shift factor, 189–190

Y

Yogurt

 allolactose and galactobiose in, 84
 lactose content, 14–16

Z

Zea mays, *see* Corn

Zein, 275, 277