

Contents

1	Introduction	1
1.1	History	1
1.2	Definition	2
1.3	Physiological Importance	2
1.4	Natural, Nature-Identical, and Artificial Products	3
1.5	Sensory Properties and Chemical Structure	3
1.6	Volatility	4
1.7	Threshold Concentration	4
1.8	Sensory Properties	4
1.8.1	Fragrance Ingredients	5
1.8.2	Flavoring Substances	6
2	Individual Fragrance and Flavor Materials	7
2.1	Aliphatic Compounds	8
2.1.1	Hydrocarbons	8
2.1.1.1	(<i>E,Z</i>)-1,3,5-Undecatriene [51447-08-6]	8
2.1.1.2	1,3-Undecadien-5-yne [166432-52-6]	9
2.1.2	Alcohols	9
2.1.2.1	3-Octanol [589-98-0]	9
2.1.2.2	2,6-Dimethyl-2-heptanol [13254-34-7]	10
2.1.2.3	(<i>E</i>)-2-Hexen-1-ol [928-95-0]	10
2.1.2.4	(<i>Z</i>)-3-Hexen-1-ol [928-96-1], Leaf Alcohol	10
2.1.2.5	1-Octen-3-ol [3391-86-4]	10
2.1.2.6	9-Decen-1 (cipher)-ol [13019-22-2]	11
2.1.2.7	10-Undecen-1-ol [112-43-6]	11
2.1.2.8	3,4,5,6,6-Pentamethylheptan-2-ol [87118-95-4]	11
2.1.2.9	(2 <i>E</i> ,6 <i>Z</i>)-2,6-Nonadien-1-ol [28069-72-9], Violet Leaf Alcohol	11
2.1.2.10	4-Methyl-3-decen-5-ol [81782-77-6]	12
2.1.3	Aldehydes and Acetals	12
2.1.3.1	Hexanal [66-25-1], Caproaldehyde, Aldehyde C ₆	13
2.1.3.2	Octanal [124-13-0], Caprylaldehyde, Aldehyde C ₈	13
2.1.3.3	Nonanal [124-19-6], Pelargonaldehyde, Aldehyde C ₉	13

- 2.1.3.4 Decanal [112-31-2], Caprinaldehyde, Aldehyde C₁₀ 14
- 2.1.3.5 Undecanal [112-44-7], Aldehyde C₁₁ 14
- 2.1.3.6 Dodecanal [112-54-9], Lauraldehyde, Lauric Aldehyde, Aldehyde C₁₂ 14
- 2.1.3.7 Tridecanal [10486-19-8] 14
- 2.1.3.8 2-Methyldecanal [19009-56-4], Methyloctylacetaldehyde, Aldehyde MOA 14
- 2.1.3.9 2-Methylundecanal [110-41-8], Methylnonylacetaldehyde, Aldehyde MNA 15
- 2.1.3.10 (*E*)-2-Hexenal [6728-26-3], Leaf Aldehyde 16
- 2.1.3.11 (*Z*)-4-Heptenal [6728-31-0] 16
- 2.1.3.12 2,6-Dimethyl-5-hepten-1-al [106-72-9] 16
- 2.1.3.13 (*E*)-4-Decenal [65405-70-1] 16
- 2.1.3.14 10-Undecenal [112-45-8] 17
- 2.1.3.15 2-Dodecenal [20407-84-5] 17
- 2.1.3.16 2,6,10-Trimethyl-5,9-undecadienal [24048-13-3] and [54082-68-7] 17
- 2.1.3.17 1,1-Dimethoxy-2,2,5-trimethyl-4-hexene [67674-46-8] 17
- 2.1.4 Ketones 18
- 2.1.4.1 3-Hydroxy-2-butanone [52217-02-4], Acetoin 18
- 2.1.4.2 2,3-Butanedione [431-03-8], Diacetyl 18
- 2.1.4.3 (*2E*)-5-Methyl-2-hepten-4-one [81925-81-7] 18
- 2.1.4.4 3,4,5,6,6-Pentamethyl-3-hepten-2-one [81786-73-4] 19
- 2.1.4.5 2,4,4,7-Tetramethyl-6-octen-3-one [74338-72-0] 19
- 2.1.5 Acids and Esters 20
- 2.1.5.1 2-Methyl-2-pentenoic Acid [3142-72-1] 20
- 2.1.5.2 Ethyl Formate [109-94-4] 21
- 2.1.5.3 (*Z*)-3-Hexenyl Formate [33467-73-1] 21
- 2.1.5.4 Ethyl Acetate [141-78-6] 21
- 2.1.5.5 Butyl Acetate [123-86-4] 21
- 2.1.5.6 Isoamyl Acetate [123-92-2] 21
- 2.1.5.7 Hexyl Acetate [142-92-7] 21
- 2.1.5.8 3,5,5-Trimethylhexyl Acetate [58430-94-7], Isononyl Acetate 21
- 2.1.5.9 (*E*)-2-Hexenyl Acetate [2497-18-9] 22
- 2.1.5.10 (*Z*)-3-Hexenyl Acetate [3681-71-8] 22
- 2.1.5.11 Ethyl Propionate [105-37-3] 22
- 2.1.5.12 Ethyl Butyrate [105-54-4] 22
- 2.1.5.13 Butyl Butyrate [109-21-7] 22
- 2.1.5.14 Isoamyl Butyrate [106-27-4] 23
- 2.1.5.15 Hexyl Butyrate [2639-63-6] 23
- 2.1.5.16 (*Z*)-3-Hexenyl Isobutyrate [41519-23-7] 23
- 2.1.5.17 Ethyl Isovalerate [108-64-5] 23
- 2.1.5.18 Ethyl 2-Methylbutyrate [7452-79-1] 23
- 2.1.5.19 Ethyl Hexanoate [123-66-0], Ethyl Caproate 23
- 2.1.5.20 Ethyl 2-Methylpentanoate [39255-32-8] 24

2.1.5.21	2-Propenyl Hexanoate [123-68-2], Allyl Caproate	24
2.1.5.22	Ethyl Heptanoate [106-30-9], Ethyl Enanthate	24
2.1.5.23	2-Propenyl Heptanoate [142-19-8], Allyl Heptanoate, Allyl Enanthate	24
2.1.5.24	Ethyl Octanoate [106-32-1], Ethyl Caprylate	24
2.1.5.25	Methyl 2-Nonenoate [111-79-5]	24
2.1.5.26	Ethyl (2E,4Z)-2,4-Decadienoate [3025-30-7], Pear Ester	25
2.1.5.27	Methyl 2-Octynoate [111-12-6], Methyl Heptin Carbonate	25
2.1.5.28	Methyl 2-Nonynoate [111-80-8], Methyl Octin Carbonate	25
2.1.5.29	Propyl (2S)-2-(1,1-Dimethylpropoxy)propanoate [319002-92-1]	25
2.1.5.30	Ethyl 3-Oxobutanoate, Ethyl Acetoacetate [141-97-9]	25
2.1.5.31	(Z)-3-Hexenyl Methyl Carbonate [67633-96-9]	26
2.1.5.32	Allyl (3-Methylbutoxy)acetate, Isopentyloxyacetic Acid Allyl Ester [67634-00-8], [67634-01-9] Allyl Amylglycolate	26
2.1.6	Miscellaneous Compounds	26
2.1.6.1	Allyl Isothiocyanate [57-06-7], Allyl Mustard Oil	27
2.1.6.2	5-Methyl-3-heptanone oxime, N-Hydroxy-5-methyl-3-heptanimine [22457-23-4]	27
2.1.6.3	3-[(Z)-3-Hexenyloxy]-propanenitrile [142653-61-0]	27
2.1.6.4	N,2,3-Trimethyl-2-isopropylbutanamide [51115-67-4] "WS 23"	28
2.1.6.5	2-Tridecenenitrile [22629-49-8]	28
2.2	Acyclic Terpenes	29
2.2.1	Hydrocarbons	29
2.2.2	Alcohols	29
2.2.2.1	Geraniol [106-24-1], (2E)-3,7-Dimethyl-2,6-octadien-1-ol	30
2.2.2.2	Nerol [106-25-2], (2Z)-3,7-Dimethyl-2,6-octadien-1-ol	32
2.2.2.3	Linalool [78-70-6], 3,7-Dimethyl-1,6-octadien-3-ol	32
2.2.2.4	Myrcenol [543-39-5], 2-Methyl-6-methylene-7-octen-2-ol	35
2.2.2.5	Citronellol [26489-01-0], 3,7-Dimethyl-6-octen-1-ol	36
2.2.2.6	Dihydromyrcenol [18479-58-8], 2,6-Dimethyl-7-octen-2-ol	37
2.2.2.7	Tetrahydrogeraniol [106-21-8], 3,7-Dimethyloctan-1-ol	38
2.2.2.8	Tetrahydrolinalool [78-69-3], 3,7-Dimethyloctan-3-ol	38
2.2.2.9	2,6-Dimethyl-2-octanol [18479-57-7], Tetrahydromyrcenol	39
2.2.2.10	7-Methoxy-3,7-dimethyl-2-octanol [41890-92-0]	39
2.2.2.11	Farnesol [4602-84-0], 3,7,11-Trimethyl-2,6,10-dodecatrien-1 (cipher)-ol	39
2.2.2.12	Nerolidol [7212-44-4], 3,7,11-Trimethyl-1,6,10-dodecatrien-3-ol	40
2.2.3	Aldehydes and Acetals	41
2.2.3.1	Citral [5392-40-5], 3,7-Dimethyl-2,6-octadien-1-al	41
2.2.3.2	Citral Diethyl Acetal [7492-66-2], 1,1-Diethoxy-3,7-dimethyl-2,6-octadiene	43
2.2.3.3	Citronellal [106-23-0], 3,7-Dimethyl-6-octen-1-al	43
2.2.3.4	7-Hydroxydihydrocitronellal [107-75-5], "Hydroxycitronellal," 3,7-Dimethyl-7-hydroxyoctan-1-al	44

- 2.2.3.5 Methoxydihydrocitronellal [3613-30-7],
3,7-Dimethyl-7-methoxyoctan-1-ol 45
- 2.2.3.6 Hydroxydihydrocitronellal Dimethyl Acetal [141-92-4],
8,8-Dimethoxy-2,6-dimethyloctan-2-ol 46
- 2.2.3.7 2,6,10-Trimethyl-9-undecenal [141-13-9] 46
- 2.2.4 Ketones 46
- 2.2.4.1 Geranylacetone [689-67-8],
6,10-Dimethyl-5,9-undecadien-2-one 47
- 2.2.5 Acids and Esters 47
- 2.2.5.1 Geranyl and Neryl Esters 48
- 2.2.5.2 Linalyl Esters 49
- 2.2.5.3 Citronellyl and Dihydromyrcenyl Esters 50
- 2.2.6 Miscellaneous Compounds 51
- 2.2.6.1 3,7-Dimethyloctanenitrile [40188-41-8] 52
- 2.2.6.2 Citronellic Acid Nitrile [51566-62-2], Citronellyl Nitrile 52
- 2.3 Cyclic Terpenes 52
- 2.3.1 Hydrocarbons 52
- 2.3.1.1 Limonene [138-86-3], 1,8-*p*-Menthadiene 54
- 2.3.1.2 γ -Terpinene [99-85-4], 1,4-*p*-Menthadiene 54
- 2.3.1.3 (-)- α -Phellandrene [4221-98-1], 1,5-*p*-Menthadiene 55
- 2.3.1.4 α -Pinene [80-56-8], 2-Pinene,
2,6,6-Trimethylbicyclo[3.3.1]hept-2-ene 55
- 2.3.1.5 β -Pinene [127-91-3], 2(10)-Pinene 56
- 2.3.2 Alcohols and Ethers 56
- 2.3.2.1 Menthol, *p*-Menthan-3-ol 56
- 2.3.2.2 Isopulegol, 8-*p*-Menthen-3-ol,
5-Methyl-2-(1-methylethenyl)-cyclohexanol [7786-67-6],
[50373-36-9] 61
- 2.3.2.3 α -Terpineol [98-55-5], 1-*p*-Menthen-8-ol 62
- 2.3.2.4 1-Terpinen-4-ol [562-74-3], 1-*p*-Menthen-4-ol 63
- 2.3.2.5 *cis*-4-(Isopropyl)cyclohexanemethanol, *cis*-Hexahydrocuminyll
Alcohol [13828-37-0], *cis*-*p*-Menthan-7-ol 64
- 2.3.2.6 Borneol, *endo*-2-Bornanol [507-70-0] 64
- 2.3.2.7 3-[(*l*)-Menthoxyl]propane-1,2-diol [87061-04-9], (*l*)-Menthyl
Glycerol Ether 65
- 2.3.2.8 Cedryl Methyl Ether [19870-74-7] and [67874-81-1] 66
- 2.3.3 Aldehydes and Ketones 66
- 2.3.3.1 Menthone, *p*-Menthan-3-one [10458-14-7] 66
- 2.3.3.2 Carvone, 1,8-*p*-Menthadien-6-one 67
- 2.3.3.3 Camphor, 1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one [76-22-2] 69
- 2.3.3.4 Fenchone, 1,3,3-Trimethylbicyclo[2.2.1]heptan-2-one
[1195-79-5] 69
- 2.3.3.5 Ionones and Homologous Compounds 69
- 2.3.3.6 Damascones, 1-(2,6,6-Trimethylcyclohexenyl)-2-buten-1-ones 74

- 2.3.3.7 α -Damascone, 1-(2,6,6-Trimethyl-2-cyclohexenyl)-2-buten-1-one [43052-87-5]; (Z)-: [23726-94-5]; (E)-: [24720-09-0] 74
- 2.3.3.8 β -Damascone, 1-(2,6,6-Trimethyl-1-cyclohexenyl)-2-buten-1-one [35044-68-9]; (Z)-: [23726-92-3]; (E)-: [23726-91-2] 74
- 2.3.3.9 β -Damasconone [23726-93-4],
1-(2,6,6-Trimethyl-1,3-cyclohexadienyl)-2-buten-1-one 75
- 2.3.3.10 δ -Damascone, 1-(2,6,6-Trimethyl-3-cyclohexenyl)-2-buten-1-one [57378-68-4]; (E)-1 α ,2 β : [71048-82-3] 75
- 2.3.3.11 1-(2,4,4-Trimethyl-2-cyclohexen-1-yl)-2-buten-1-one [39872-57-6] 75
- 2.3.3.12 1,3,4,6,7,8a-Hexahydro-1,1,5,5-tetramethyl-2H-2,4a-methanonaphthalen-8(5H)one [23787-90-8] 76
- 2.3.3.13 Nootkatone, 4,4a-Dimethyl-6-isopropenyl-4,4a,5,6,7,8-hexahydro-3H-naphthalen-2-one [4674-50-4] 76
- 2.3.3.14 Methyl Cedryl Ketone, "MCK," Acetyl Cedrene 76
- 2.3.4 Esters 77
- 2.3.4.1 α ,3,3-Trimethylcyclohexane-1-methanol Formate [25225-08-5] 77
- 2.3.4.2 (–)-Menthyl Acetate, (–)-*p*-Menthan-3-yl Acetate [2623-23-6] 78
- 2.3.4.3 *rac*-Menthyl Acetate [29066-34-0] 78
- 2.3.4.4 Menthanyl Acetate, Dihydroterpinyl Acetate [58985-18-5] 78
- 2.3.4.5 5-Methyl-2-(1-methylethyl)cyclohexyl 2-Hydroxy-propanoate [59259-38-0], *l*-Menthyl Lactate 79
- 2.3.4.6 α -Terpinyl Acetate [80-26-2], 1-*p*-Menthen-8-yl Acetate 79
- 2.3.4.7 Nopyl Acetate [35836-72-7],
(–)-2-(6,6-Dimethylbicyclo[3.1.1]hept-2-en-2-yl)-ethyl Acetate 80
- 2.3.4.8 Bornyl acetate, 2-*endo*-bornanyl Acetate [76-49-3] 80
- 2.3.4.9 Isobornyl Acetate [125-12-2], 2-*exo*-bornanyl Acetate 80
- 2.3.4.10 *N*-substituted *p*-Menthane-3-Carboxamides 81
- 2.3.4.11 *N*-ethyl-*p*-menthane-3-carboxamide [39711-79-0], "WS 3" (1) 81
- 2.3.4.12 *N*-(4-Methoxyphenyl)-*p*-menthane-3-carboxamide [68489-09-8] "WS 12" (2) 82
- 2.3.4.13 *N*-[[5-methyl-2-(1-methylethyl)cyclohexyl]carbonyl]glycine Ethyl Ester [68489-14-5] "WS 5" (3) 82
- 2.3.4.14 Methyl 2,2-dimethyl-6-methylene-1-cyclohexanecarboxylate [81752-87-6] 82
- 2.3.4.15 Ethyl 2,6,6-Trimethyl-1,3-cyclohexadiene-1-carboxylate [35044-59-8] 82
- 2.3.4.16 Guaiyl Acetate [94333-88-7] 83
- 2.3.4.17 Cedryl Acetate [77-54-3] 83
- 2.3.4.18 Vetiveryl Acetate [62563-80-8] 83
- 2.3.5 Miscellaneous Compounds 84
- 2.3.5.1 8-Mercapto-*p*-menthan-3-one [38462-22-5] 84
- 2.3.5.2 1-*p*-Menthene-8-thiol [71159-90-5] 85
- 2.4 Other Cycloaliphatic Compounds 85
- 2.4.1 Alcohols and Ethers 85

- 2.4.1.1 1-(4-Isopropylcyclohexyl)ethanol [63767-86-2] 85
- 2.4.1.2 4-Cyclohexyl-2-methyl-2-butanol [83926-73-2] 86
- 2.4.1.3 2-Methyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)butanol
[72089-08-8] 86
- 2.4.1.4 2-Methyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-2-buten-1-ol
[28219-60-5] 87
- 2.4.1.5 5-(2,2,3-Trimethyl-3-cyclopenten-1-yl)-3-methylpentan-2-ol
[65113-99-7] 87
- 2.4.1.6 2-Ethyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-2-buten-1-ol
[28219-61-6] 88
- 2.4.1.7 3-Methyl-5-(2,2,3-trimethyl-3-cyclopenten-1-yl)-4-penten-2-ol
[67801-20-1] 88
- 2.4.1.8 2-Methyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-4-pentenol
[104864-90-6] 88
- 2.4.1.9 3,3-Dimethyl-5-(2,2,3-trimethyl-3-cyclopenten-1-yl)-4-penten-2-ol
[107898-54-4] 89
- 2.4.1.10 [1-Methyl-2-(1,2,2-trimethyl[3.1.0]hex-3-ylmethyl)cyclopropyl]methanol [198404-98-7] 89
- 2.4.1.11 3-*trans*-Isocamphylcyclohexanol [4105-12-8] 89
- 2.4.1.12 1-(2,2,6-Trimethylcyclohexyl)hexan-3-ol [70788-30-6] 90
- 2.4.1.13 2,5,5-Trimethyl-1,2,3,4,4a,5,6,7-octahydronaphthalen-2-ol
[41199-19-3], Ambrinol 91
- 2.4.1.14 1-[[2-(1,1-Dimethylethyl)cyclohexyl]oxy]-2-butanol,
[139504-68-0] 91
- 2.4.1.15 2-(2,2,7,7-Tetramethyltricyclo[6.2.1.0](1,6)undec-5-en-5-yl)propan-1-ol, 2-(2,2,7,7-Tetramethyltricyclo[6.2.1.0](1,6)undec-4-en-5-yl)propan-1-ol, [929625-08-1], [1001252-30-7] 92
- 2.4.1.16 Cyclododecyl Methyl Ether [2986-54-1],
Methoxycyclododecane 92
- 2.4.1.17 (Ethoxymethoxy)cyclododecane [58567-11-6] 92
- 2.4.2 Aldehydes 93
- 2.4.2.1 2,4-Dimethyl-3-cyclohexene Carboxaldehyde [68039-49-6] 93
- 2.4.2.2 4-(4-Methyl-3-penten-1-yl)-3-cyclohexene Carboxaldehyde
[37677-14-8] 93
- 2.4.2.3 1-Methyl-4-(4-methyl-3-penten-1-yl)-3-cyclohexene
Carboxaldehyde [52474-60-9] 93
- 2.4.2.4 4-(4-Hydroxy-4-methylpentyl)-3-cyclohexene Carboxaldehyde
[31906-04-4] 94
- 2.4.2.5 2-Methyl-4-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2-butenal
[3155-71-3] 94
- 2.4.3 Ketones 94
- 2.4.3.1 2-Pentylcyclopentanone [4819-67-4] 94
- 2.4.3.2 2-Heptylcyclopentanone [137-03-1] 95
- 2.4.3.3 2,2,5-Trimethyl-5-pentylcyclopentanone [65443-14-3] 95

- 2.4.3.4 Dihydrojasmane[1128-08-1],
3-Methyl-2-pentyl-2-cyclopenten-1-one 96
- 2.4.3.5 (Z)-Jasmone [488-10-8],
3-Methyl-2-[(2Z)-2-penten-1-yl]-2-cyclopenten-1-one 96
- 2.4.3.6 4-*tert*-Pentylcyclohexanone [16587-71-6] 97
- 2.4.3.7 6,7-Dihydro-1,1,2,3,3-pentamethyl-4(5*H*)-indanone
[33704-61-9] 97
- 2.4.3.8 Cyclopentadecanone [502-72-7] 97
- 2.4.3.9 (E/Z)-3-Methyl-5-cyclotetradecen-1-one [259854-70-1] 98
- 2.4.3.10 (Z)-4-Cyclopentadecenone [14595-54-1] 98
- 2.4.3.11 3-Methylcyclopentadecanone [541-91-3], Muscone 99
- 2.4.3.12 3-Methylcyclopentadecenone [82356-51-2] 99
- 2.4.3.13 Cyclohexadecanone [2550-52-9] 100
- 2.4.3.14 5-Cyclohexadecen-1-one [37609-25-9] 100
- 2.4.3.15 (E/Z)-7/8-Cyclohexadecenone (Mixture of Isomers) [888642-03-9],
[3100-36-5] 101
- 2.4.3.16 (E/Z)-8-Cyclohexadecenone [3100-36-5] 101
- 2.4.3.17 (Z)-9-Cycloheptadecen-1-one [542-46-1], Civetone 102
- 2.4.3.18 1-(5,5-Dimethyl-1-cyclohexen-1-yl)-4-penten-1-one
[56973-85-4] 102
- 2.4.3.19 2-Cyclohexyl-1,6-heptadien-3-one [313973-37-4] 102
- 2.4.3.20 1-Spiro[4.5]dec-7-en-7-yl-4-penten-1-one,
1-Spiro[4.5]dec-6-en-7-yl-4-penten-1-one [224031-70-3] 103
- 2.4.3.21 2,3,8,8-Tetramethyl-1,2,3,4,5,6,7,8-octahydro-2-naphthalenyl Methyl
Ketone [54464-57-2], (1-1,2,3,4,5,6,7,8-Octahydro-2,3,8,8-
tetramethyl-2-naphthyl)ethan-1-one [166090-45-5],
OTNE 103
- 2.4.3.22 4-(2-Butenylidene)-3,5,5-trimethyl-2-cyclohexene-1-one and
Isomers [13215-88-8] 104
- 2.4.3.23 Methyl 2,6,10-Trimethyl-2,5,9-cyclododecatrien-1-yl Ketone
[28371-99-5] 104
- 2.4.3.24 2-Hydroxy-3-methyl-2-cyclopenten-1-one;
3-Methyl-2-cyclopenten-2-ol-1-one [80-71-7], Cyclotene 105
- 2.4.3.25 4-(1-Ethoxyvinyl)-3,3,5,5-tetramethylcyclohexanone
[36306-87-3] 105
- 2.4.4 Esters 106
- 2.4.4.1 2-*tert*-Butylcyclohexyl Acetate [88-41-5], OTBCHA 106
- 2.4.4.2 4-*tert*-Butylcyclohexyl Acetate [32210-23-4], PTBCHA 106
- 2.4.4.3 (Z)-3-Hexenyl Cyclopropanecarboxylate [188570-78-7] 107
- 2.4.4.4 4,7-Methano-3a,4,5,6,7,7a-hexahydro-5 (or 6)-Indenyl Acetate
[2500-83-6] (or [5413-60-5]) 107
- 2.4.4.5 Allyl 3-Cyclohexylpropionate [2705-87-5] 107
- 2.4.4.6 Ethyl 2-Ethyl-6,6-dimethyl-2-cyclohexenecarboxylate [57934-97-1],
and Ethyl 2,3,6,6-Tetramethyl-2-cyclohexenecarboxylate
[77851-07-1] 108

- 2.4.4.7 Allyl Cyclohexyloxyacetate [68901-15-5], Cyclohexyloxyacetic Acid Allyl Ester 108
- 2.4.4.8 [2-[1-(3,3-Dimethylcyclohexyl)ethoxy]-2-methyl-propyl] Propanoate [141773-73-1] 108
- 2.4.4.9 [2-[1-(3,3-Dimethylcyclohexyl)ethoxy]-2-oxo-ethyl] Propanoate; 2-(1-Oxopropoxy)-acetic Acid 1-(3,3-Dimethylcyclohexyl)ethyl Ester [236391-76-7] 109
- 2.4.4.10 Methyl Jasmonate [1211-29-6], 3-Oxo-2-[(2Z)-2-pentenyl]cyclopentaneacetic Acid Methyl Ester 109
- 2.4.4.11 Methyl Dihydrojasmonate [24851-98-7], Methyl (3-oxo-2-pentylclopentyl)acetate 110
- 2.4.4.12 Methyl 2-Hexyl-3-oxocyclopentanecarboxylate [37172-53-5] 112
- 2.4.5 Miscellaneous Compounds 113
- 2.4.5.1 1,5-Dimethylbicyclo[3.2.1]octan-8-one oxime [75147-23-8] 113
- 2.5 Aromatic Compounds 113
- 2.5.1 Hydrocarbons 113
- 2.5.2 Alcohols and Ethers 113
- 2.5.2.1 Benzyl Alcohol [100-51-6] 114
- 2.5.2.2 Phenylethyl Alcohol [60-12-8], 2-Phenylethyl Alcohol 115
- 2.5.2.3 Phenylethyl Methyl Ether [3558-60-9] 116
- 2.5.2.4 Phenylethyl Isoamyl Ether [56011-02-0] 116
- 2.5.2.5 Acetaldehyde Ethyl Phenylethyl Acetal [2556-10-7] 116
- 2.5.2.6 1-Phenylethyl Alcohol [98-85-1], Styrallyl Alcohol 116
- 2.5.2.7 Dihydrocinnamic Alcohol [122-97-4], 3-Phenylpropanol 117
- 2.5.2.8 2,2-Dimethyl-3-phenyl-1-propanol [13351-61-6] 117
- 2.5.2.9 2,2-Dimethyl-3-(3-methylphenyl)propanol [103694-68-4] 118
- 2.5.2.10 α,α -Dimethylphenylethyl Alcohol [100-86-7], 2-Methyl-1-phenyl-2-propanol, α,α -Dimethyl Benzyl Carbinol 118
- 2.5.2.11 2-Methyl-4-phenyl-2-butanol [103-05-9], α,α -Dimethylphenylethyl Carbinol 118
- 2.5.2.12 2-Methyl-5-phenylpentanol [25634-93-9] 119
- 2.5.2.13 3-Methyl-5-phenylpentanol [55066-48-3] 119
- 2.5.2.14 3-Methyl-1-phenyl-3-pentanol [10415-87-9], Phenylethyl Methyl Ethyl Carbinol 119
- 2.5.2.15 Cinnamic alcohol [104-54-1], 3-Phenyl-2-propen-1-ol 120
- 2.5.3 Aldehydes and Acetals 120
- 2.5.3.1 Benzaldehyde [100-52-7] 121
- 2.5.3.2 Phenylacetaldehyde [122-78-1] 121
- 2.5.3.3 Phenylacetaldehyde Dimethyl Acetal [101-48-4] 122
- 2.5.3.4 Dihydrocinnamaldehyde [104-53-0], 3-Phenylpropanal 122
- 2.5.3.5 Hydratropaldehyde [93-53-8], 2-Phenylpropanal 122
- 2.5.3.6 Hydratropaldehyde Dimethyl Acetal [90-87-9] 123
- 2.5.3.7 4-Methylphenylacetaldehyde [104-09-6] 123
- 2.5.3.8 3-Methyl-5-phenylpentanal [55066-49-4] 123
- 2.5.3.9 3-(4-Ethylphenyl)-2,2-dimethylpropanal [67634-15-5] 123

2.5.3.10	3-[4-(1,1-Dimethylethyl)phenyl]propanal [18127-01-0]	124
2.5.3.11	Cyclamenaldehyde [103-95-7], 2-Methyl-3-(4-isopropylphenyl)propanal	124
2.5.3.12	3-(3-Isopropylphenyl)butanal [125109-85-5]	125
2.5.3.13	4- <i>tert</i> -Butyl- α -methyl dihydrocinnamaldehyde [80-54-6], 2-Methyl-3-(4- <i>tert</i> -butyl-phenyl)propanal, BMHCA	125
2.5.3.14	2-Methyl-3-[4-(2-methylpropyl)phenyl]propanal [6658-48-6]	126
2.5.3.15	Cinnamaldehyde [14371-10-9], 3-Phenyl-2-propenal	126
2.5.3.16	α -Amylcinnamaldehyde [122-40-7], 2-Pentyl-3-phenyl-2-propenal	127
2.5.3.17	α -Hexylcinnamaldehyde [101-86-0], 2-Hexyl-3-phenyl-2-propenal	127
2.5.4	Ketones	128
2.5.4.1	Acetophenone [98-86-2], Methyl Phenyl Ketone	128
2.5.4.2	4-Methylacetophenone [122-00-9], <i>p</i> -Tolyl Methyl Ketone	128
2.5.4.3	Benzylacetone [2550-26-7], 4-Phenyl-2-butanone	129
2.5.4.4	Methyl 2-Naphthyl Ketone, Methyl β -Naphthyl Ketone [93-08-3]	129
2.5.4.5	Benzophenone [119-61-9], Diphenyl Ketone	129
2.5.4.6	5-Acetyl-1,1,2,3,3,6-hexamethylindane [15323-35-0]	130
2.5.4.7	4-Acetyl-1,1-dimethyl-6- <i>tert</i> -butylindane [13171-00-1]	130
2.5.4.8	5-Acetyl-1,1,2,6-tetramethyl-3-isopropylindane [68140-48-7]	131
2.5.4.9	1-(5,6,7,8-Tetrahydro-3,5,5,6,8,8-hexamethyl-2- naphthalenyl)ethanone [1506-02-1], [21145-77-7], 6-Acetyl-1,1,2,4,4,7-hexamethyltetraline (AHTN)	132
2.5.5	Esters of Aromatic Alcohols and Aliphatic Acids	133
2.5.5.1	Benzyl Acetate [140-11-4]	133
2.5.5.2	Benzyl Propionate [122-63-4]	133
2.5.5.3	Benzyl Isovalerate [103-38-8]	133
2.5.5.4	Phenylethyl Acetate [103-45-7]	134
2.5.5.5	Phenylethyl Isobutyrate [103-48-0]	134
2.5.5.6	Phenylethyl Isovalerate [140-26-1]	134
2.5.5.7	1-Phenylethyl Acetate [50373-55-2], Styrallyl Acetate	134
2.5.5.8	α -Trichloromethylbenzyl Acetate [90-17-5]	135
2.5.5.9	α,α -Dimethylphenylethyl Acetate [151-05-3]	135
2.5.5.10	α,α -Dimethylphenylethyl Butyrate [10094-34-5]	136
2.5.5.11	Cinnamyl Acetate [21040-45-9]	136
2.5.6	Aromatic Acids	136
2.5.6.1	Phenylacetic Acid [103-82-2]	136
2.5.7	Esters Derived from Aromatic and Aliphatic Acids	137
2.5.7.1	Benzoates	137
2.5.7.2	Phenylacetates	138
2.5.7.3	Cinnamates	138
2.5.8	Miscellaneous Compounds	139

- 2.5.8.1 Musk ketone [81-14-1], 3,5-Dinitro-2,6-dimethyl-4-*tert*-butylacetophenone 139
- 2.5.8.2 Cinnamonnitrile [4360-47-8] 140
- 2.5.8.3 3-Methyl-5-phenyl-2-pentenitrile [93893-89-1] 140
- 2.5.8.4 2-Cyclohexylidene-2-phenylacetoneitrile [10461-98-0] 141
- 2.5.8.5 Methyl Anthranilate [134-20-3] 141
- 2.5.8.6 Methyl *N*-Methylantranilate [85-91-6] 142
- 2.5.8.7 2-Ethyl-*N*-methyl-*N*-(3-methylphenyl)butanamide [406488-30-0] 142
- 2.6 Phenols and Phenol Derivatives 143
- 2.6.1 Phenols, Phenyl Esters, and Phenyl Ethers 143
- 2.6.1.1 Diphenyl Ether [101-84-8] 143
- 2.6.1.2 Phenoxyacetic Acid 2-Propenyl Ester [7493-74-5], Phenoxyacetic Acid Allyl Ester 143
- 2.6.1.3 Thymol [89-83-8], 2-Isopropyl-5-methylphenol 144
- 2.6.1.4 Anethole [104-46-1], 1-Methoxy-4-(1-propenyl)benzene 144
- 2.6.1.5 1-(Cyclopropylmethyl)-4-methoxybenzene [16510-27-3] 146
- 2.6.1.6 2-Phenoxyethyl Isobutyrate [103-60-6] 146
- 2.6.1.7 Methyl 2-Naphthyl Ether [93-04-9], 2-Methoxynaphthalene, Nerolin Yara-Yara 146
- 2.6.1.8 Ethyl 2-Naphthyl Ether [93-18-5], 2-Ethoxynaphthalene, Nerolin Bromelia 147
- 2.6.1.9 Isobutyl 2-Naphthyl Ether [2173-57-1], 2-(2-Methyl-2-propoxy)naphthalene 147
- 2.6.1.10 Hydroquinone Dimethyl Ether [150-78-7], 1,4-Dimethoxybenzene 147
- 2.6.1.11 Isoeugenol [97-54-1], 2-Methoxy-4-(1-propenyl)phenol 147
- 2.6.1.12 Isoeugenol Methyl Ether [93-16-3], Methyl Isoeugenol 148
- 2.6.1.13 Eugenol [97-53-0], 2-Methoxy-4-allylphenol 148
- 2.6.1.14 Eugenol Methyl Ether [93-15-2], Methyl Eugenol 149
- 2.6.1.15 Eugenol Acetate [93-28-7] 149
- 2.6.1.16 Propenylguethol [94-86-0], 2-Ethoxy-5-(1-propenyl)phenol 150
- 2.6.1.17 *p*-Cresyl Phenylacetate [101-94-0] 150
- 2.6.2 Phenol Alcohols and Their Esters 150
- 2.6.2.1 Anise Alcohol [105-13-5], 4-Methoxybenzyl Alcohol 151
- 2.6.2.2 Anisyl Acetate [104-21-2] 151
- 2.6.3 Phenol Aldehydes 151
- 2.6.3.1 *p*-Anisaldehyde [123-11-5], 4-Methoxybenzaldehyde 151
- 2.6.3.2 2-Methyl-3-(4-methoxyphenyl)propanal [5462-06-6] 152
- 2.6.3.3 Vanillin [121-33-5], 4-Hydroxy-3-methoxybenzaldehyde 152
- 2.6.3.4 Veratraldehyde [120-14-9], 3,4-Dimethoxybenzaldehyde 155
- 2.6.3.5 Ethylvanillin [121-32-4], 3-Ethoxy-4-hydroxybenzaldehyde 155
- 2.6.3.6 Heliotropin [120-57-0], Piperonal, 3,4-Methylenedioxybenzaldehyde 156

- 2.6.3.7 2-Methyl-3-(3,4-methylenedioxyphenyl)propanal [1205-17-0] 157
- 2.6.4 Phenol Ketones 157
- 2.6.4.1 4-Methoxyacetophenone [100-06-1], Acetanisole 158
- 2.6.4.2 4-(4-Hydroxyphenyl)-2-butanone [5471-51-2], Raspberry Ketone 158
- 2.6.5 Phenolcarboxylates 158
- 2.6.5.1 Salicylates 158
- 2.6.5.2 Resorcylic Acid Esters 160
- 2.7 *O*-, *O,S*- and *S,S*-Heterocycles 161
- 2.7.1 Cyclic Ethers 161
- 2.7.1.1 1,8-Cineole [470-82-6], 1,8-Epoxy-*p*-menthane, Eucalyptol 162
- 2.7.1.2 Rose Oxide [16409-43-1],
4-Methyl-2-(2-methyl-1-propenyl)tetrahydropyran 163
- 2.7.1.3 Menthofuran [494-90-6],
3,6-Dimethyl-4,5,6,7-tetrahydrobenzofuran 164
- 2.7.1.4 Linalool Oxide,
2-Methyl-2-vinyl-5-(α -hydroxyisopropyl)tetrahydrofuran 165
- 2.7.1.5 6-Butyl-3,6-dihydro-2,4-dimethyl-2H-pyran [24237-00-1] 165
- 2.7.1.6 1,5,9-Trimethyl-13-oxabicyclo[10.1.0]trideca-4,8-diene [13786-79-3] 166
- 2.7.1.7 3a,6,6,9a-Tetramethyldodecahydronaphtho[2,1-b]furan [6790-58-5], [3738-00-9], Ambergris Oxide 166
- 2.7.1.8 Decahydro-2,6,6,7,8,8-hexamethyl-2H-indeno[4,5-b]furan [338735-71-0] 167
- 2.7.1.9 4-Hydroxy-2,5-dimethyl-3(2*H*)-furanone [3658-77-3], Pineapple Ketone 168
- 2.7.1.10 2-Ethyl-4-hydroxy-5-methyl-3(2*H*)-furanone [27538-10-9] and 5-Ethyl-4-hydroxy-2-methyl-3(2*H*)-furanone [27538-09-6], "Homofuraneol" 169
- 2.7.1.11 Maltol [118-71-8], 3-Hydroxy-2-methyl-4*H*-pyran-4-one 169
- 2.7.1.12 Ethylmaltol [4940-11-8], 2-Ethyl-3-hydroxy-4*H*-pyran-4-one 169
- 2.7.1.13 2-Isobutyl-4-methyltetrahydro-2*H*-pyran-4-ol [63500-71-0] 170
- 2.7.1.14 3-Pentyltetrahydro-2*H*-pyran-4-ol Acetate [18871-14-2] 170
- 2.7.1.15 4,6,6,7,8,8-Hexamethyl-1,3,4,6,7,8-hexahydrocyclopenta[g]benzopyran [1222-05-5], "HHCB" 171
- 2.7.1.16 2-Butyl-4,4,6-trimethyl-1,3-dioxane [54546-26-8] 172
- 2.7.1.17 6-Isopropyl-9-methyl-1,4-dioxaspiro[4,5]decane-2-methanol [63187-91-7], Menthone Glycerine Acetal 172
- 2.7.1.18 Hexahydro-1',1',5',5'-tetramethyl-spiro[1,3-dioxolane-2,8'(5'*H*)-[2*H*-2,4a]-methanonaphthalene] [154171-76-3], [154171-77-4] 172
- 2.7.1.19 2-(2,4-Dimethyl-3-cyclohexenyl)-5-methyl-5-(1-methylpropyl)-1,3-dioxane [117933-89-8] 173

- 2.7.1.20 Dodecahydro-3,8,8,11a-tetramethyl-5*H*-3,5a-epoxynaphth[2,1-
c]oxepin [57345-19-4], 8,13;13,20-Diepoxy-15,16-dinor-
8β*H*-labdane, Ambraketol 173
- 2.7.1.21 (4a*R*,5*R*,7a*S*,9*R*)-Octahydro-2,2,5,8,8,9a-hexamethyl-4*H*-4a,9-
methanozuleno[5,6-*d*]-1,3-dioxole
[211299-54-6] 174
- 2.7.1.22 Phenylacetaldehyde glycerine Acetal [29895-73-6],
2-Benzyl-1,3-dioxolan-4-methanol 174
- 2.7.1.23 2,4,6-Trimethyl-4-phenyl-1,3-dioxane [5182-36-5] 175
- 2.7.1.24 4,4a,5,9b-Tetrahydroindeno[1,2-*d*]-*m*-dioxin [18096-62-3] 175
- 2.7.1.25 4,4a,5,9b-Tetrahydro-2,4-dimethylindeno[1,2-*d*]-1,3-dioxin
[27606-09-3] 175
- 2.7.1.26 7-Methyl-2*H*-1,5-benzodioxepin-3(4*H*)-one [28940-11-6],
Watermelon Ketone 176
- 2.7.1.27 Ethyl (2-Methyl-[1,3]dioxolan-2-yl)-acetate [6413-10-1],
(2-Methyl-[1,3]dioxolan-2-yl)-acetic Acid Ethyl Ester 176
- 2.7.1.28 Ethyl (2,4-Dimethyl-[1,3]dioxolan-2-yl)-acetate [6290-17-1],
(2,4-Dimethyl[1,3]dioxolan-2-yl)-acetic Acid Ethyl Ester 176
- 2.7.1.29 1-(3-Methylbenzofuran-2-yl)-ethanone [23911-56-0] 177
- 2.7.1.30 *cis*-2-Methyl-4-propyl-1,3-oxathiane [59323-76-1] 177
- 2.7.2 Lactones 177
- 2.7.2.1 γ-Octalactone [104-50-7] (R = *n*-CH₃-(CH₂)₃-) 178
- 2.7.2.2 γ-Nonalactone [104-61-0] (R = *n*-CH₃-(CH₂)₄-), the So-Called
"Aldehyde C₁₈" 178
- 2.7.2.3 γ-Decalactone [706-14-9] (R = *n*-CH₃-(CH₂)₅-) 178
- 2.7.2.4 γ-Undecalactone [104-67-6] (R = *n*-CH₃-(CH₂)₆-), the So-Called
"Aldehyde C₁₄" 179
- 2.7.2.5 β-Methyl-γ-octalactone [39212-23-2], Whiskey Lactone 179
- 2.7.2.6 3-Hydroxy-4,5-dimethyl-2(5*H*)-furanone [28664-35-9],
Sotolone 179
- 2.7.2.7 5-Ethyl-3-hydroxy-4-methyl-2(5)-furanone [698-10-2], Abhexone,
Maple Furanone 180
- 2.7.2.8 δ-Decalactone [705-86-2] 180
- 2.7.2.9 δ-Dodecalactone [713-95-1] 181
- 2.7.2.10 15-Pentadecanolide [106-02-5], 15-Hydroxypentadecanoic Acid
Lactone 181
- 2.7.2.11 15-Pentadec-11-enolide/15-Pentadec-12-enolide (Mixture of (*E*)-
and (*Z*)-Isomers) [34902-57-3] 183
- 2.7.2.12 9-Hexadecen-16-olide [28645-51-4],
Oxacycloheptadec-10-en-2-one, Ambrettolide 183
- 2.7.2.13 Oxa-16-hexadecanolides 184
- 2.7.2.14 1,12-Dodecanedioic Acid Ethylene Ester [54982-83-1] 184
- 2.7.2.15 1,13-Tridecanedioic Acid Ethylene Ester [105-95-3], Ethylene
Brassylate (n = 11) 185
- 2.7.2.16 Coumarin [91-64-5], 2*H*-1-benzopyran-2-one 185

2.7.2.17	Dihydrocoumarin [119-84-6], 3,4-Dihydro-2 <i>H</i> -benzopyran-2-one	186
2.7.3	Glycidates	187
2.7.3.1	Ethyl 3-Phenylglycidate [121-39-1], the So-Called "Aldehyde C ₁₆ Special"	187
2.7.3.2	Ethyl 3-Methyl-3-phenylglycidate [77-83-8], the So-Called "Aldehyde C ₁₆ ," Strawberry Aldehyde	187
2.7.4	Miscellaneous Compounds	188
2.7.4.1	2-Furylmethanethiol [98-02-2], Furfuryl Mercaptan	188
2.8	<i>N</i> - and <i>N,S</i> -Heterocycles	188
3	Natural Raw Materials in the Flavor and Fragrance Industry	193
3.1	Introduction	193
3.2	Isolation of Natural Fragrance and Flavor Concentrates	194
3.2.1	Essential Oils	195
3.2.2	Extracts	196
3.3	Survey of Natural Raw Materials	197
4	Analytical Methods/Quality Control	265
5	Safety Evaluation and Regulatory Aspects	267
5.1	Flavoring Substances	267
5.2	Fragrance Ingredients	268
	References	271
	Formula Index	317
	Subject Index	341

