

This is the revised (2022) index
for the 2020 Penguin Press edition of
Nose Dive: A Field Guide to The World's Smells
(c) 2020, 2022 Harold McGee

Index

Page numbers in italics refer to tables and larger diagrams; in boldface, to drawings of molecules; in boldface italics, to drawings alongside tables.

- À la recherche du temps perdu* (Proust), xiii, 102
abalone mushroom, 354, 355
ABCC11 gene, 123–24
absinthe, 259
absolutes, in fragrances, 456, 457
acaridial, **569**
acetaldehyde, **16**, 241, 345, 573, 585
Acetaria: A Discourse of Sallets (Evelyn), 242
acetic acid, **17**, **41**; and basic metabolism, 40–41; in human excrement, 95–98; and feet, 115; in the vagina, 116; and plant esters, 156–61; and tree woods, 200; and fruits, 298, 304; and yeasts, 365; in wetlands smells, 370; in woodsmoke, 410; from plastics, 429; in chocolate, 531–32; in spoiled foods, 547; in fermented foods, 550, 554; in wines, 570; in beers, 579; in vinegar, 582–85; and old books, 601
acetic acid bacteria, 550, 556, 579, 582
aceto balsamico di Modena tradizionale, 583, 584
acetone, common ketone, **16**, 51, 105, 111, 345
acetophenone, 176–77, 223
acetyl pyrroline, **181**, 182, 263, 277, 396, 508, 519, 527
achioté, 291, 292
acids, 15–16, 17, 19–20, 40–44; and basic metabolism, 35, 40–41, 47–49; names, 46–47; in animal body innards and excrement, 64–65, 67–68; in human excrement, 97–99; in breath, 105; and feet, 115; in the vagina, 116; in armpits, 120–22; and plant esters and lactones, 156–61, 158–59; in compost, 347; in petrichor/gaiaichor, 366–67; in wetland smells, 370; in woodsmoke, 410, 412; from plastics, 429; in tobacco, 448; in dairy foods, 498–500, 527; in lamb and mutton, 504; in molasses, 524; in chocolate, 531; in dirty/spoiled smells, 545–47; in fermented foods, 535, 548, 552–85. *See also* branched-chain acids; *names of specific acids and fermented foods*
acid smells, **16**, 26, 60, 77, 205, 347, 412, 495
acrolein, 16, 205
adhesives, 431, 433
aerobes, aerobic metabolism and microbes, 34–35, 65, 70, 73–74, 347–48, 363
African basil, 255
Aftel, Mandy, 481
Aftel Archive of Curious Scents, 481
agarwood, 199, 199–200, 444, 446, 462, 464, 482
Agatharchides, 185
aging, effects of: on human skin smells, 112; in tobacco, 448; in orris root, 464; in meats and fish, 538–41; in condiments, 538, 561; in wines, 573–74; in sake, 581; in vinegars, 582–83; in spirits, 586–87
agricole rums, 590
ajwain or ajowan, 282, 282
alarm smells, 88, 140
alcohol, defining molecule in alcoholic beverages, **41**. *See also* ethanol (ethyl alcohol)
alcohols (fermented beverages), 533–34, 550, 569–81, 585–91: “nosing,” 585–86. *See also names of specific beverages*
alcohols (molecules), 15, 40–44, 47–49; and basic metabolism, 39; and human skin, 113–14, 120; and fresh green plant smells, 154–56, 155, 156; and component in fruity esters, 16, 18, 156–60; produced by many fungi, 349–51; produced by yeasts, 363–64; distillation to concentrate, xxvi, 453; in perfumery, 453–55; in fatty cooked bouquet, 489; in dirty/spoiled smells, 545–47; in fermented foods and beverages, 550–51, 558, 569–91. *See also names of specific alcohols*
aldehydes, 15, 44–45, 47–49; and basic metabolism, 39, 44–45; in pet smells, 73; and human skin, 110, 111–13; and fresh green plant smells, 152, 154–56, 155, 156; in grains and nuts, 275–80; in fungi, 349–51; in sea creatures, 382–85; and petrichor/gaiaichor, 366–67; in crayons, 431; in perfumes, xvi, 479, 480; in cooked-food bouquets, 488–91; in fried foods, 494–95; in sun-dried laundry smell, 536; in stale/rancid foods, 536–39; in cured hams, 540; in dirty/spoiled smells, 545–47; in fermented foods, 558–59, in wines, 570, 573; in beers, 577. *See also names of specific aldehydes*
ales, xvi, 536, 578, 578
algae, 134, 138, 341, 375–79, 397–400, 461, 517–18
allicin (diallyl thiosulfinate), 272, 512
alliiums, garlic family, 183, 264, 272, 511–13
allspice, 289, 291, 292
allyl carbon group, 412
allyl isothiocyanate, **182**, 272
allyl sulfides, 512, 554
almond extract, 20, 177–78, 279
almond mushroom, 354, 355
almonds, 177–78, 279, 280, 303, 452
Alpine or wild strawberry, 298, 300, 308–9
Alvin expedition, 28
alysium flowers, 225
Amazonian ants, xxix, 126, 163
amber, 472

- amber naphthofuran (Ambrox), 468, 468–69, 474, 475
- ambergis, 468–69, 469; and animal-derived fragrances, 464–66; and composing perfumes, 478–79; and plant ambers, 471–72; and synthetic fragrances, 474
- ambrette, 472, 472
- ambrettolide, 472
- ambrinol, 468
- American country hams, 539–40
- amines, 11, 15, 60–62; and protein breakdown, 58, 59; and animal body, 60–62; in animal death/decay smells, 63–64; in excrements, 68, 70–72; in signaling excretions, 79; in human metabolism, 94; in urine, 103; in sexual smells, 117–18; and unpleasant fishiness in seafoods, 386–87. *See also* TMA and TMAO (trimethylamine and its oxide)
- amino acids, 40, 58–59; and protein breakdown, 58; and sulfurous and branched-chain volatiles, 59–60; and phenols and cresols, 59–60; and animal smells, 59–62, 73; and nitrogenous volatiles, 61; and human urine and feet, 103, 115; and plant volatile production, 174–75, 180–81; and cooked-food smells, 489–501, 516, 528, 530; and chocolate, 530; and tea leaves, 543; and fermented foods, 555, 558
- aminoacetophenone, 75, 176, 177, 181, 182, 313, 520
- ammonia, xxv, 4, 10–11, 10, 15, 21; name, 15; and anaerobic metabolism, 35; and protein breakdown, 59–60; in animal smells, 60; in urine, 67, 103; in excrement, 68, 70–72, 97–99; in seafoods, 386–87, 397; in spoiled foods, 547; in cured eggs, 541; in fermented foods, 557, 566
- anaerobes, anaerobic metabolism and microbes, 34–35; and basic carbon chains, 43; and animal innards, 64–65; and excrement, 67, 97; and animal skin, 74; and animal signaling secretions, 82; and compost, 347; and ethanol production by yeasts, 363; and wetlands/soggy soil smells, 370; and fermented vegetables, 553
- Anatomy of Dessert, The* (Bunyard), 295
- anchovies, 541
- androstenone, 101, 117, 504
- anethole, 178, 178–79, 179, 258, 281–82
- Angel (fragrance), 480, 480
- angelica root, 472, 472–74
- animals: bodies and metabolism, 56–62; characteristic volatiles, 58–62; death and decay, 55–56, 63–64; innards and excrements, 64–68, 68, 69–73, 78–80, 97, 97–99; pet smells, 73–76; and signaling, 77–90; and fragrance materials, 442, 464–71, 469–70; animal fats in cooking, 497–98, 498. *See also* barnyard smells; dung; excrement; meats and meaty smells; urine; *names of specific animals*
- anisaldehyde, 179, 179, 237
- anise hyssop, 251, 252
- anise seed, 274, 281–82, 282
- anisole, 179, 179
- annatto, 291, 292
- anthranilates, 180, 234
- antiperspirants, 123, 125
- antiseptics, 59, 143, 426. *See also* phenol
- ants: Amazonian, xxix, 126, 163; and volatile secretions, 17, 46, 88–89, 89; and carbon-chain names, 46; and evolutionary forces, 140, 592; and terpenoids, 163
- aonori, 400, 400
- apocrine glands and sweat, 110–11, 120–22, 123, 125
- Appenzeller cheese, 116, 127, 567, 568
- apple brandies, 587
- apple mint, 253, 253
- apples, xxi, 302–3, 304, 523
- apricots, 161, 303, 306
- aqua vitae, 453, 588
- aquaculture (fish), 390–91
- aquatic fatty bouquet, fresh and cooked, 507
- arborvitae, 165, 191
- Archaean Eon, 25
- Aristotle, 55, 210, 212
- Armagnac, 587, 587
- armpits, 119–22, 121–22, 124
- Arnold, Dave, 304, 327
- aromatic hardwood trees, 193–200
- aromatic roots, 273–74
- aromatic shrubs, 203–5
- Artemisia* plants, 203, 245, 259, 444, 449–50
- artichoke, 515, 515
- arugula, 246
- arum flowers, 214, 215, 216
- asafetida, 183, 282, 282
- ascaridole, 261
- ashtrays, 448
- Asian flowers, 212–35
- Asian pears, 305
- Asian spices, 288–90
- Asiatic lily, 218, 231, 232
- asparagus, 181–82; effects on urine, 102–3; cooked, 514–15
- Aspergillus* fungi, 344, 544, 551–52, 559–62, 580–81
- asphalt, 59, 67, 403, 418, 420
- aster flowers, 227, 227
- asteroids, 18–20
- astrochemistry, 3–21
- Atala, Alex, xxviii–xxvix, 126, 140
- attar, 304, 441, 452
- “attentional capture” by smells, 221, 465
- Austin, David, 240
- automobiles: interiors, 432, 433; tires, 429, 433
- autumn leaves, 345, 346, 544
- avocados, 197, 198, 327–28, 330
- awamori, 588, 589
- ayu (sweet fish), 389
- baby’s breath flowers, 228, 228
- Bachelard, Gaston, 484, 528
- bacteria (microbes): aerobes and anaerobes, 34–35; and animal smells, 58, 64–67; and death and decay, 63; and pet smells, 75; and human body, 94–99, 105–6, 108, 110, 114–16, 119–22; and soil, 340, 341, 347; and compost, 346–47; and truffle symbiosis, 359; and “wet-up” soil smell, 366; and dirty/spoiled smells, 545–47; and fermented foods and drinks, 532, 548–50, 549, 563–64, 566–67. *See also* microbes and microbiomes; *names of specific bacteria*
- Baekeland, Leo, 428
- baijiu (Chinese spirits), 589–91, 590
- baked foods and baking, 363, 458, 490, 492–93, 516–17, 520–22, 527–28, 555
- Bakelite plastic, 428–29
- Ballard, Robert, 28
- balms, tree secretions, 193–95
- balsamic: smells, 176–78, 193–96, 461, 478, 482; vinegars, 550, 582–83, 584
- balsams, 177, 185, 195
- bamboo shoots, 516, 517
- bananas, 327, 328
- barberry, 215, 216
- barley, 276, 276, 576
- barnyard smells: and protein breakdown, 59; and cresols, 59–60, 67–68, 71; and animal excrements and manure, 67, 70, 79–80, 97–99; in vanilla, 292; and *Brettanomyces* yeasts, 365, 572, 575, 579; in tobacco, 448; in plant-derived fragrance material, 458, 462; in lamb meat, 504; in cured hams, 539; in wine aromas, 572, 575; in beer aromas, 578–79. *See also* dung; excrement
- Bartram, William, 295, 296, 309
- basements, 546
- basil varieties, 251, 252, 254–56, 255, 256
- basmati rice, 181, 263, 277, 277, 514, 518
- basswood (linden or lime tree), 229
- Baudelaire* (Sartre), xix
- Bauer, Albert, 474
- bay laurel, 196–98, 197
- beach strawberries, 309, 310
- beans, dried, 277–78; and cooked foods, 522, 522; and fermented foods, 555–57; and fermented condiments, 557–60
- beans, green, 514, 515
- beans, stinky, 278
- Bear, Isabel, 339–40, 366–67
- Beaux, Ernest, 474, 479
- beavers, 83, 84, 470. *See also* castoreum

- Becher, Paul, 591–92
 bedbugs, 88–89
 beef, 497, 498, 503–4, 503–5, 512–13, 513. *See also* meats and meaty smells
 beef extract, 503–4
 beef tallow, 452, 497–98, 504, 506, 512–13
 beer, 575–79: and hops, 264, 576–77, 576–77; and yeasts, 362–65; and malts, 576–79, 578–79; and stale/rancid smells, 536, 538, 538
 bees, 88, 138, 218–19, 332, 471, 525
 beeswax, 45, 470, 471, 493–94
 beet sugar, 524, 524
 beetles, 88, 89, 214–15, 218
 beets, 270–71, 271, 516, 517
 Beijing douzhi, 556
 Bell, Peter, 571
 bell peppers, 108, 181, 317–18
 Benn, Charles D., 114, 122–23
 benzaldehyde, 19, 177: and molecules in asteroids, 19; and plant carbon-ring metabolism, 180; and cherrywood, 201; and wood-pulp paper, 201, 601; and flower scents, 217, 219; and heliotrope, 237; and almonds, 279; and mahleb, 285; and rose family fruit seeds, 303; and stone fruits, 306; and mushrooms, 354; and roux, 521
 benzene, 13, 174: and burning organics, 414; and fossil organics, 420; discovery and naming, 425; and solvents, 431; and toxicity, 434–35; and high-temperature cooking, 494
 benzene methanethiol, 368
 benzenoids, molecules that include a benzene ring; and primordial and asteroid molecules, 14, 20; and volatile metabolism in plants, 173–80; and burning organic materials, 412–15; and fossil organics and petrochemicals, 420–21, 425; and toxicity, 435. *See also* phenyl ring molecules; cinnamyl carbon rings; benzyl rings; *names of specific molecules*
 benzo[a]pyrene (BaP), 434–35
 benzoate esters, 219, 329
 benzofurans/benzofuranones, 257, 269–70, 281
 benzoic acid, 177, 311, 425
 benzoin resins, 173, 177, 194, 195, 425
 benzyl: alcohol, 177, 354; esters, 177; rings, 177
 bergamot, 252, 253, 320, 325, 325–26, 459, 479
 berries, 153, 311–14, 312, 314
 bifidobacteria, 96, 98
 birch tar, 416; oil, 462, 462
 bird excrement, 68, 68, 72
 bitter almonds, 177–78, 279–80, 303
 bitter orange, 234, 235, 322, 459
 bitumen, 418–19, 421, 422
 black beans, fermented, 560, 560
 black chanterelles, 356, 357
 black cumin seed, 282, 282
 black eggs of Owakudani, 36–37
 black garlic, 512
 black pepper, 267, 286, 287
 black salt, xxvi, 37
 black teas, 543, 544
 black truffles, 360, 360, 361
 black trumpet mushrooms, 356
 black walnuts, 280, 281
 blackberries, 311, 312
 blackcurrants, 81, 183, 312, 312–13
 blood and bloody smells, 351, 502–3, 506
 blood oranges, 322, 323
 blue cheeses, 551, 566, 567
 blue water lily, 222–23, 223
 blueberries, 311, 312
 “Blumen der Luft” (Müller), 77
 body odors, xix, 104–28: mouth and breath, 104–7; clean skin, 111–13; scalp and hair, 113–14; feet, 114–16; sexual organs, 116–18; armpits, 119–22; efforts to reduce, 122–24; emotional effects of, 124–26; echoes in foods, 126–28. *See also* sweat; sweaty-smelling volatiles
 boiling (cooking), 489–90, 492. *See also names of specific foods*
 bolete mushrooms, 343, 353
 borage, xxvi, 246, 247
 borneol, 165, 166
 Bosch, Carl, 71
Boswellia, frankincense, 193, 194
Botrytis cinerea, noble rot, 574
 bouquets, defining groups of volatile molecules: of death, 64; of pets, 73–74; of truffles, 358–59; of oysters, 393–94; of seaweeds, 400; of cooking methods, 488–91; meaty, 503–4; aquatic and cooked-fish, 507; beany, 522; stale and rancid, 536–37; from household microbes, 545–46; from fermentation microbes, 548–49; vinous, 570; in beers, 577; spiritous, 586
 boxwood, 203, 204
 Boyle, Robert, 466, 471, 472
 braising, 492
 branched-chain acids, 19, 51, 59–60, 60: and excrement, 67, 70–71, 97; and pets, 74; and goats and sheep, 85–87, 500, 504; and human body, 97, 115–16, 120–22; and tobacco, 448; and lamb and mutton meat, 504; and dirty/spoiled smells, 545–46; and fermented foods, 548–49, 566–67, 582; and cheeses, 566–67
 brandies, 587, 587–88
 brassicas. *See* cabbage and cabbage family vegetables
 breads, 363, 520–21, 521–22: staling and spoilage, 537–38, 538, 547; sourdough and salt-rising types, 555–56, 556
 breastfeeding and breast milk: and excrement, 95–96; and mother’s body odor, 124
 breath: and smell perception, xv, xx, xxv; of pets, 74; and medical diagnosis, 92; and human metabolism, 94, 104–7, 106; and mouth microbiome, 105–8. *See also* mouth; mouthwash
 “breath of the wok,” 494
Brettanomyces yeasts, 344, 365, 365, 572, 572, 579
Brevibacterium, 115, 116, 550
 Brie cheese, 551, 566, 567
 Brieger, Ludwig, 61
 brining: fermented foods, 127, 548, 550, 557, 561; cured foods, 539, 541
 broad bean paste, fermented, 560
 Brock, Thomas D., 28
 broiling and broiled foods, 493
 bromine: in waters and aquatic life, 133, 374, 379–81, 380, 397; in whiskies, 401–2
 bromoform, 380
 bromophenols: in seafoods, 381, 396; in whiskies, 402
 brown algae, 384, 397–98, 399
 brown mushrooms, 353
 Browning, Frank, 302–3
 browning reactions in cooking, 489–91, 492, 494, 521, 527, 529, 532, 583. *See also* caramel/caramelization; Maillard reactions in cooking
 BTEX, toxic petrochemicals, 435, 493
 buckwheat, 276, 276: buckwheat honey, 526, 526; buckwheat shochu, 588, 589
 building materials, 431–32
 bulb vegetables, 268, 271–72
 Bumpass Hell, 27
 Bunyard, Edward A., 295, 304
 burgundy truffles, 360, 360
 burley tobacco, 447–48
 butane, 45, 420
 butenethiol, 83
 butter, 498, 498, 564, 565: and carbon-chain names, 46; and cooking, 521, 522, 527, 527–28; and rancidity, 537, 537
 butterflies, 77, 88, 89: and flower volatiles, 141, 177, 217–19
 butyric acid, 19, 46, 48, 563–64: and anaerobic metabolism, 35; and basic carbon chains, 41–42, 51; in excrement, 95, 97–98; beneficial effects, 98, 564; in feet smells, 115; in plant esters and lactones, 156–57, 159; and strawberries, 310; and ginkgo seeds, 332; and milks, 499; in breads, 555–56; in cheeses, 563–64, 568
 cabbage and cabbage family vegetables, 182, 183, 246, 246, 271–72, 271, 272: cooked, 515–16, 515; fermented 553, 554. *See also names of specific vegetables*

- cabbage smell of sulfur molecules, 10, 14, 21, 36, 59, 81, 182, 183, and frequently throughout
- cachaça, 590, 590–91
- Cadamosto, Alvise, 496
- cadaverine, 62, 62, 63–64, 74, 105, 117, 553
- cade oil, 462, 462
- CAFOs (concentrated animal feeding operations), 70–72
- cakes, 527–28
- calamus, sweet flag, 463, 464
- Calasso, Roberto, 75–76
- California: bay leaf, 197, 198; redwoods, 190; sage, 203, 204
- Callin, Robert, 477
- Callery or Bradford pear, 215–16
- Calone, 476, 480
- Camembert cheese, 551, 566, 567
- camphor, 165, 166: and non-smell qualities, 144–45, 164; tree, 198; and aromatic shrubs, 203; and chrysanthemums, 224, 227, 232; and lavender, 227, 251; and rosemary, sages, and yerba buena, 251–52, 445; and basil, 255–56; and galangal, 273; and coriander seed, 282–83; and moxa smoke, 449; and Persian/Arab perfumery, 464; and synthetic fragrance materials, 475
- Campi Flegrei, 23
- Campitello Quarry, 415
- cancers, associated with volatiles, 99, 434, 494
- candles, 403, 422, 431, 432: scented, 493, 494
- candy cap mushrooms, 356, 356
- cane sugar, 524
- cannabis (marijuana), xvi, xxii, 162–63, 165, 202, 264–65, 449, 449, 576
- canned foods: peaches, 114; tuna, 507–8; squashes, 517–18; corn, 519–20; olives, 554
- cantaloupe, 315, 316
- Canterbury Tales, The* (Chaucer), 146–47
- cape gooseberries, 317
- capers, 554, 554
- capsaicin, 145, 286, 288
- capsicum peppers, chilis, 267, 288, 288, 317–18, 318, 514, 515, 517, 518
- caramel/caramelization, 4–5, 172–73, 284, 480, 486–87, 486–88, 490, 500, 523, 528, 583. *See also* browning reactions in cooking
- caraway, 281, 282
- caraway carvone, 166, 167, 250, 281
- caraway thyme, 254, 254
- carbohydrates, 40, 57–58, 96, 98, 172, 401, 415. *See also names of specific carbohydrates*
- carbon, 6, 8, 11–12, 424: hero of chemical and biological evolution, 38, 403–5. *See also* Hero Carbon
- carbon-based volatile molecules: properties, 11–12; primordial, 13–21; carbon-oxygen families, 15–18, 40–45; life's starter set of simple chains, 39–49; innovations of plants and insects, 136, 140–41, 149–84, 591–92; in aquatic life, 382–83. *See also* branched-chain acids; carbon ring volatiles; *names of specific molecules and families*
- carbon dioxide, 8: odorless, 10; supercritical, 456
- carbon ring volatiles: primordial, 11–14, 19–20; from amino acid breakdown, 58–60, 61–62; from plant metabolism, 154, 161–62, 164–80; from pyrolysis, 410, 412–15; in fossil organics, 420–21, 425–27, 428–29. *See also names of specific molecules and families*
- cardamom, 290, 290
- cardboard smells, 275, 499, 536–37, 537, 539, 577
- Carlsberg Brewery, 365
- carnations, 228, 228
- carnivores, 69, 79, 214–15, 220
- carotenoid pigment fragments, 151–52, 171, 288, 316, 322, 400, 448, 496, 516
- carp, 390, 391
- carpets, 74, 429–30, 545
- carrots, 269–70, 270, 510, 513
- carvacrol, 165, 166, 250, 261
- carvones, 166, 167, 167, 200, 250, 254, 257, 281
- caryophyllene, 170
- cassia, 131, 185, 193, 196–98, 197, 289, 451
- castoreum, 84, 425, 465, 469, 470
- cat ketone, 81, 203, 312, 543
- cat urine, 78, 80–81, 81, 88, 108, 121, 203, 300, 503
- catfish, 390, 391
- Cato, 496
- cattleya orchid, 237, 238
- Catullus, 118
- cauliflower, 183, 517, 518
- caviar, 541, 541
- cedar trees, 143, 170, 187, 190–92, 192, 282, 319, 321, 446
- cedrol, 170
- celeriac, celery root, 269–70, 270, 510, 513
- celery, 256–59, 257–58, 281–83, 510
- celery family: herbs, 256–59, 257, 472; vegetables, 269–70, 270; spice seeds, 281–83, 282. *See also names of specific plants and materials*
- celery seeds, 281, 282
- cellulose, 150, 151–52, 172, 208, 343, 345, 411, 428, 601
- celtuce, 514, 515
- century eggs, 541, 541
- cep/cêpe, bolete mushroom, 343, 353, 356
- chamomile, 227, 227
- Chanel, Coco, 450, 479
- Chanel No. 5, 474, 479, 479
- chanterelles, 353, 356, 357
- char (fish), 389, 390, 391
- charcoal, 406, 416, 424, 444, 493. *See also* carbon
- charred meat, and skatole, 61, 61–62
- Chaucer, Geoffrey, 146–47
- cheddar cheese, 563, 567–68, 568
- cheese mites, 569
- cheeses, xiv–xv, xxv, 11, 19, 21, 41, 43, 84–86, 115–16, 126–27, 548–51, 563–69. *See also names of specific cheeses*
- cheesy smells, 563–69: and primordial acids, 19–20; and starter-set acids, 35, 42, 43, 48–49; and protein breakdown, 58–60; and animal bodies, 65, 68, 74–75, 83, 85, 89–90; and human bodies, 93; in excrement, 95, 97–99; in breath, 105–6; on feet, 114–16; in rancid milk products, 537; in salt-rising breads, 555
- chemesthesis, 144–45
- Chemical History of a Candle, The* (Faraday), 403
- “chemical” smells, 16, 20, 44, 45, 47, 51, 59, 61; in plant materials, 142–43, 205, 219; in seaweeds, 379–81; from fire and pyrolysis, 404, 414, 420–21, 429
- cherry fruits, 201, 306, 307, 579
- cherry wood, 201
- chervil, 258, 258
- chestnut honey, xv, 75, 526, 526
- Chevreul, Michel, 84, 424
- Cheyne, George, 67
- chi xiang* baijiu, 589, 590
- chicken: excrement, 70; fat, 497, 498; meat, 504, 505
- chicory root, 170, 579
- chili paste, fermented, 560
- chili peppers. *See* capsicum peppers, chilis
- China: body odors in, 106, 114, 122–23, 127; flowers from, 215, 224, 231–34, 239–40; incense in, 441, 444, 449
- Chinese (garlic) chive, 264
- Chinese chrysanthemum, 224, 232, 232
- Chinese gooseberries (kiwis), 312, 313
- Chinese green teas, 542
- Chinese rice wines, 579–80
- Chinese roses, 232, 232, 239, 240
- Chinese ruffles, 360, 361
- Chinese vinegars, 584, 584–85
- Chinking vinegar, 584–85
- chives, 263–64, 264
- chlorine and chlorinated volatiles, 133, 205, 374, 379–80, 380, 435, 575
- chloroform, 205, 380
- chlorophyll, 32, 151–52. *See also* photosynthesis
- chocolates, 528, 530–32, 531
- chrysanthemums, 211, 224, 224, 227, 227, 232, 232
- chypres (perfumes), 461, 480
- cider vinegar, 582, 583

- cilantro, xxviii–xxix, 50, 88, 189, 258, 258–59, 270, 270: root, 302. *See also* coriander
 cinnamaldehyde, 176, 176, 180, 197–98, 289, 475–76
 cinnamic acid and alcohol, 176, 176–77, 365
 cinnamon, 153, 176, 185, 197, 197–98, 267, 288–89, 289, 291, 451
 cinnamon basil, 255, 255
 cinnamyl carbon rings, 176, 176
 citron, 319, 320–21, 321
 citronella, 262, 460, 460
 citronellal, 168, 169, 229, 262, 325
 citronellol, 167, 168, 229, 262, 456, 457
 citrus fruits, 164, 167–69, 318–26: mutually defining peel terpenoids, 319; in perfumery, 326, 454, 459, 459, 478–79. *See also names of specific citrus fruits*
 city hams, 539
 civet, small animal and its secretion, 83, 84, 332, 464–65, 469, 469, 479
 civetone, 84, 469, 474
 clams, 386, 395, 396, 509, 509
 clarified butter, 498
 Clark, Eleanor, 372–73, 381, 392
 clary sage, 460, 460, 480
 Classen, Constance, 92
 clementine, citrus fruit, 320, 322, 323
Clostridium bacteria, 549: and unusual breads, 555–56; Beijing douzhi, 556
 clovers, 177, 178, 206, 206, 225, 226
 cloves, 106, 122, 179, 228, 274, 289, 289, 412–13
 CO₂. *See* carbon dioxide
 coal, 12, 135, 404–5, 409, 419–24, 434
 coal gas, 175, 297, 421–22
 coal tar, 403–5, 422, 424–25, 426–27, 434–35, 474, 476
 “Coal-Tar Contemplations” (Robinson), 403
 cobnuts, 279–80, 280
 coccolithophores (algae), 375, 378
 cockroaches, 88
 cocoa, 530–32, 531: and cocoa-like smells, 16, 45, 491
 cocoa butter, 530
 coconut, 113, 161, 280, 281: oil, 497, 497
 cod, 387, 388, 388, 507, 508
 coffees, xxv, 528–30, 529–30
 Cognac, 587, 587
 cola flavors, 595–96, 596
 collards, 516
 cologne, 326, 450, 474, 478
 colostrum and mother’s body odor, 124
 combustion, 408–10: and smoke smells, 411–15; and incense, 443–50
 comets, 18, 25, 373
 commensal microbes, 95–96, 108, 118, 125. *See also* microbes and microbiomes
 common button or white mushroom, 353–55
 complex and composite nature of smells, xxi–xxx, 595–96
 composing with volatiles, 477–78
 compost, 70, 214, 346–47
 Comté cheese, 567, 568
 concentrated animal feeding operations. *See* CAFOs
 Concord grapes, 175, 298, 313–14, 314
 concretes (perfumery), 455–56
 condiments, 325, 381, 399, 550, 552, 583: fermented seeds, 557–60; fermented fish, 561–63
 Confucius, 224
 conifer trees, 135, 138–39, 190–93, 192, 208–9, 406, 414. *See also names of specific trees*
 Cook, James D., 434
 cooked food bouquets, 488–91, 502
 cooked fruits, 523, 523–24
 cookies, 528
 cooking and cooked foods, 484–532: sensory appeal, 484–86; creation of new volatiles with pyrolysis, 486–88; basic volatile bouquets, 488–91; methods, 492–94. *See also specific methods, ingredients, foods*
 cooking fats and oils, 494, 495–98
 cooking methods, 492–94
 copal resins, copaiba, 196, 195, 445, 474
 coprophagy, 66
 coriander, 88, 258, 258, 267, 282, 282–83. *See also* cilantro
 cork taint, 575, 575
 corn (maize), 276: fresh, cooked, or canned, 517, 518, 519, 520; popcorn or porridge, 519, 520; alkaline-treated for tortillas, chips, hominy, xiv–xv, 519–20, 520
 corn salad (mâche), 246, 247
 Corner, E. J. H., 297, 333–34
 corpse flower (titan arum), 214, 216
Corynebacterium, 120, 122
 cosmopolitan herbs, 263–65, 264
 costus (fragrant root), 463, 464
 Coty, François, 480
 coumaric acid and derivatives, 178–80
 coumarin, 178, 179, 198, 206–7, 285, 291, 427, 444, 475, 478–79
 country hams, 539, 540
 crabs, 508, 508
 cranberries, 311–12, 312
 crayfish, 508
 crayons, 431, 432
 creams, cow milk, 499–500, 500, 564, 564
 crème fraîche, 564, 564
 creosote, 416, 425–26, 434
 creosote bush, 204, 204–5
 cresols, 20, 59, 416: and protein breakdown, 59–60; in excrements, 67, 70–71, 97; in animal signaling smells, 79–80, 88, 470; and lamb meat, 86, 504; in flower scents, 215, 219–20, 231, 233, 458, 465; in pyrolysis and smoke, 413–14, 471; in wood tar, 416, 425–26; in grilling and broiling, 493
 Cresp, Olivier, 480
 crocuses, 171, 223, 223, 284, 285
 crustaceans, 376, 508
 cubenol, 398
 cucumbers, xiv, 156, 314–16, 315, 382–83, 536; pickled, 554
 cucurbit family vegetables, 314–16, 382
 culantro, 258, 258
 Cumae, 22, 23
 cumin seed, 126, 166, 267–68, 283, 282
 cuminaldehyde, 166, 167, 283
 curing: tobacco, 447–49, 449; wild rice, 519; various foods, 535, 539–44, 541, 543–44
 curry leaf, 263, 263
 curry plant, 260, 260
 curry spice mixes, 273, 595–96, 596: and body odors, 112–13
 cuttlefish, 395–96
 cyanide, 35, 137, 178, 180, 279, 303, 515–16
 cyanobacteria, 32–33, 348–49, 375–76, 390–91, 461
 cymbidium orchid, 224, 224
 cymene, 165
 daffodils, 226, 226
daiginjo sake, 581
 daikon radish, 271
 daisy family: shrubs, 203, 205; flowers, 227, 227; vegetables, 245, 245; herbs, 259–60, 260
 Dalby, Liza, 482
 damascenone, 171, 172, 239, 510, 587
 damascone, 171, 172
 damask rose, 187, 238–39, 240
 dandelions, 225, 226
 dankness and moldy smells, 341, 351, 546, 575
 dashi, Japanese soup stock, 398, 561
 dates, 185, 326–27, 328
 Davidson, Alan, 533, 534
 daylilies, 231, 232
 dead-horse arum flower, 215, 216
 death smells, xxv–xxvi, 55, 63–64, 75–76. *See also* cadaverine; putrescine
 decadienals, 50, 50, 51, 488, 494–95, 497, 505, 516, 518
 decalactones, 161, 499, 527, 543
 decanal, 50, 50, 111
 decanoic acid, 47
 decatrienals, 50, 50, 385, 537
 decenals, 50, 50, 323, 324, 459, 495
 decomposition, xiv, 535: and primordial volatiles, 10, 14; of animal bodies, 56, 62, 63–64; ecological role of fungi, 341–43, 345–47; of seaweeds, 401; and fermentation, 534, 535, 545–47, 548–52. *See also* rot and rotting
 deep-sea hydrothermal vents, 28–29, 37, 62
 deer, 79, 82, 501: musk deer, 78, 83, 84, 313, 466–68

- deodorants, 93, 119, 122–25
 devil's tongue flower, 215, 216
 diacetyl, landmark butter volatile, 498, 564; on human skin, 112; in pyrolysis and smoke, 411; in sweet cooked bouquet and foods, 490, 512, 527; and fermentations, 549; in wine, 572
 diallyl disulfide, 182, 512
 diatoms, 375
 dibromiodomethane, 380
 Dickinson, Emily, 441
 dictyopterenes, 384, 398
 diesel tree, 196
 diethyl ether, 436
 digestive systems, 35, 64, 66–67, 94–99, 105
 dihydroactinidiolide, 171
 dill: herb, 257, 257; seed, 268, 281, 282
 dill ether, 166, 167, 257
 dillisk seaweed, 400
 dimethoxybenzene, 229
 dimethoxytoluene, 232, 239
 dimethyl disulfide and trisulfide, 215
 dimethyl sulfide (DMS), 377: in green plants, 182, 188; in truffles, 360; in wetlands, 371; ocean air, 378–79, 401; in fish and shellfish, 382, 388, 391, 395–97, 509; in seaweeds, 397–400; in cooked bouquet, 489–90; in vegetables, 182, 510–11, 514, 517, 519, 554; in green tea, 543
 dimethylamine, 20, 61, 386
 dinoflagellates, 375–76
 “dirty” smells, 59, 159, 348: in flowers, 219–21; in fragrances, 458, 465
 dish cloths and sponges, 545
 dishwashers, 545, 546
 disinfectants, 20, 59, 67, 250, 379, 413, 417, 425, 426, 449
 “Dissertation upon Roast Pig, A” (Lamb), 330–31
 distillation: destructive, 416, 462; of fossil organics, 422; and isolating single volatiles, 424–27; ancient collection of volatiles in vapors, 451–52; and extracting fragrance volatiles, 451–55, 456; of alcohol, 453–54, 585; dry, 471, 481
 distilled spirits, 585–91. *See also names of specific spirits*
 distilled vinegar, 582, 583
 diterpenoids, 191, 448
 DMS. *See* dimethyl sulfide (DMS)
 DMSP (dimethylsulfoniopropionate), 378, 395, 398, 401, 509
 dog smells, 66, 69, 73–75, 75, 82, 83, 463
 dogs' sense of smell, xxix–xxx, 92
 dou chi (fermented black beans), 560, 560
 doubanjiang (fermented broad bean paste), 560, 560
 douzhi (fermented mung bean broth), 556, 556
 dried fruit, 523
 dried herbs, 538, 538
Drosophila. *See* fruit flies
 dry cooking methods, 492–94
 dry-cured sausages, 551, 562, 563
 Duchesne, Antoine, 160, 309
 duck eggs, cured, 541, 541
 duck fat and duck meat, 497, 498, 505, 505
 dudaim or pocket melon, 316
 dulse, 399, 400
 dung, 66, 69, 87, 141, 214–15, 343. *See also* barnyard smells; excrement
 Dunlop, Fuchsia, 127, 594
 durian, 182–83, 295, 296–97, 333, 333–35
 Earl Grey tea, 169, 325–26, 459
 Earth, smells on, 22–37, 131–34, 339–41, 406–7, 418–21. *See also* soils
 earwax, 123
 East German Ministry for State Security, 92
East Wind Melts the Ice (Dalby), 482
 eastern red cedar, 191, 192
 Eau de Cologne, 326, 450, 454, 459, 478, 479; mint variety, 252, 253
 Eau Sauvage (fragrance), 479, 480
eaux de vie, distilled alcohols, 453–54, 474
 eccrine glands and sweat, 109–10, 114–15
 ectocarpenes, 384
 eftazymo, bacteria-raised bread, 555, 556
 eggplant, 517, 518
 eggs and eggy smells, 10, 21, 35–37, 500–501, 501: rotten, 28, 36, 501, 501; cured duck and fish eggs, 541, 541
 eglantine rose, 241
 Egyptian water lilies, 218, 222–23, 223
 electrons: and molecules, 7–8, 11–12; and energy for molecule building, 29–33, 406
 Elizabeth I, Queen of England, 225
 Emmental cheese, 550, 567, 568
 endive, 245, 245
 enflourage, 452–53, 457
 English boxwood, 203, 204
 enzymes, active molecules that can generate volatiles, 57–58; in animal life and death, 63, 107–8, 180; in human body odor, 120; and plant leaf volatiles, 154–56, 161–62, 382; inactivated by heat, 244, 514; and cabbage-family defenses, 271, 285; and allium-family defenses, 272, 511–13; and soy beaniness, 277–78; and vanilla, 293; and soil fungi and mushrooms, 343, 350, 354; and water-dwelling creatures, 382–85, 390, 393, 506–7; and tobacco, 447; and olive oil, 496; and milk and its products, 499; and grain malts and beers, 525, 575–76; and chocolate, 532; in curing and fermentation, 534–35, 539–44; and staling, 536; and tea, 542–44; and dirty/spoiled smells, 545; in Asian grain starters, 558; and fish sauces, 561; and cheeses, 565; and wines, 571, 575
 epazote, 246–47, 261, 261
Epic of Gilgamesh, 190, 191
 Epoisses cheese, 116, 127, 550, 566, 567
 epoxy decenal, 502, 502–3, 506, 538
 eryngi mushroom, 354
 essential oils, 238, 441, 442, 452–53, 456, 464, 478, 493
 esters, alcohol-acid combinations, 16, 18: and skunks, 83; and insects, 88–89; and great variety in plants, 155, 156–61, 158–59; ring-ester lactones, 160–61; terpenoid esters, 169; benzenoid esters, 174–75, 176, 177; thiol esters, 183; in flowers, 219, 230, 235, 235, 236, 239; defining volatiles in fruits, 297–300, 298–99, 299–300, 301; in specific fruits and cooked fruits, 297–334, 523; from yeasts, 363–65, 550, 591–92; in fragrance compositions, 478; and chocolate, 531; in cured hams, 539; in teas, 543; in dirty/spoiled smells, 545; in fermented vegetables, 554; in cheeses, 555–57; in soy sauce and miso, 558–59; in salami, 562; in wines, 570; hop and beer esters, 576–78; in rice wines, 580–81; in vinegars, 582–84; in spirits, 586, 587–91; biological roles, evolution of flowers and fruits, 590–91. *See also names of specific esters*
 estragole, 178–79, 179, 198, 208, 255–56, 258, 259, 260, 281
 ethane, 420
 ethanethiol, 14
 ethanol (ethyl alcohol), 17, 208, 345, 351–52, 363–64, 453–55, 550, 570. *See also* alcohols (molecules)
 ether and etherality, 436
 ethyl acetate, 298, 298, 304, 570
 ethyl butyrate, 159, 299
 ethyl decadienoate, 157, 299
 ethyl formate, 18, 158
 ethyl methylbutyrate, 299, 305, 334
 ethyl sulfanyl ethanethiol, 334
 ethylene, 13
 ethylguaiacol, 412, 413: in yeasts, 365; in woodsmoke, 412–13; in beer, 578–79; in barrel-aged spirits, 586
 ethyloctanoic acid, 85, 121, 500
 ethylphenol, 79–80, 365, 365
 eucalyptol, 166, 167, 199: in mouthwashes, 106; and “chemical” smells of plants, 142–43; and non-smell volatile qualities, 144–45; and aromatic trees, 198–99, 199; in basil, 255; in ginger, turmeric, and galangal, 273
 eucalyptus, 142–43, 198–99, 289
 eugenol, 106, 179, 179, 180, 201, 228, 231, 255, 262, 289, 316, 327, 412–13

- European (white) lily, 226
 European rose, 229, 230, 238–40
 euryhaline fish, 388–91, 390, 391
 Evelyn, John, 242, 243, 434
 evolution: of matter, 4–8, 11–12, 18–20; role of carbon, 11–12, 38–39; of Earth, 24–29, 33–34; of life, 29–33, 34–35, 38–39, 56; of animals, 57–58, 64–65, 77–78; of land plants, 131–41; likely coevolution of yeasts, animals, flowers, and fruits, 140, 590–91; of aquatic plants and animals, 375–81, 383; influence of fire, 406–7; human, 407, 435–36, 485, 534
 excrement, 56, 65–68, 69–73, 78–82; human, 95–99, 97
 extremophile microbes, 28, 31, 546
- Faraday, Michael, 403–4, 425
 farnesene, 171
 fasting breath, 91, 105–6
 fats and oils, 12, 16, 40: and animal smells, 58, 86; and goat and sheep smells, 84–85; and human skin and scalp, 111–14; and grains 275; and nuts, 279; in aquatic creatures, 382–85; in cooking, 488, 494–98; and stale/rancid smells, 275, 536–37, 537. *See also* lipids; *names of specific oils and fats*
 fatty acids, 16, 40, 42: primordial, 17, 19; from basic metabolism, 35, 40; starter-set, 42–44, 42, 47–49; names, 46–47; from protein breakdown, 58–59; in goats and sheep, 85–86; in excrement, 97–99; on sweaty feet, 115–16; armpit odors, 120–22; and dirty/spoiled smells, 545–47, 545–46, 547; and fermented foods, 548, 550, 553; fermented milks and cheeses, 563–69. *See also* branched-chain acids; *names of specific fatty acids*
 fatty bouquet: cooked, 488–89, 507, 536; aquatic, 507; beany, 522
 Fäviken, restaurant, 418
 fecal smells, 61, 67, 86, 88, 97–98, 500: in flowers, 209–20; in white pepper, 286; in tobacco, 447–48; in fragrances, 465; in grilled meats, 493; in fermented foods, 562–63, 566. *See also* excrement
 feet, 109, 114–16, 115, 127, 550
 feijoa, 329
 feline, 80
 fenchone, 166, 167, 282
 fennel: herb, 258, 258, 598; seed, 282, 282
 fenugreek, 113, 275–76, 283–84, 284, 300. *See also* sotonon
 fermentation, controlled microbial activity: 534–35, 548–52; and tobacco, 447–48; and butter flavor, 498; and chocolate production, 532; fermented foods, 552–92; and pu-erh teas, 544. *See also* names of specific fermented foods
 ferns, 135, 189, 189, 478
 feta cheese, 565
 Feynman, Richard, 533–34
 fiber, dietary, 96–98
 field mint, 249, 250
 figs, 307, 308
 filamentous fungi, 343
 filbertone, 279–80, 280
 fir trees, xxii, 163, 190, 192, 192, 279, 361–62
 fire, 403–4, 406–10, 411–15. *See also* smoke
 Firmenich, 80–81, 93, 108, 368, 474
 fish, 388–91: cooked, 493, 506–8; cured, 541; fermented, 561–63. *See also* names of specific fishes and fish products
 fish pastes and sauces, 561–62
 fishy smells: primordial and nitrogenous molecules, 14–15, 20, 61–62, 72, 79, 103, 117–18, 181–82, 203, 215, 347; fresh shared with land plants, 382–83; from unsaturated oils, 382–85, 488, 536–37; stale, 384–87; in the kitchen, 387, 506–8; in tobacco, 447–48
 Five Senses, *The* (Serres), 3, 22, 55
 flatulence, 99–101
 fleshy fruits, 138, 296
 flies, common, 63, 138, 141, 214–15, 218, 220, 352. *See also* fruit flies
 flour beetles, 88, 89
 flours, 537–38, 538. *See also* breads; grains
 flowering plants, angiosperms, 135, 138, 139, 163, 193, 216, 260, 591–92
 flowers, 210–41: pleasantness, 77, 131; evolution for plant reproduction, 137–39, 140–41, 212–13, 590–91; common volatiles, 162, 167–68, 168, 171, 175–77, 175, 176, 177, 218–19; malodorous, 214–16; volatile mixtures, 216–19; “dirty” notes in, 219–21; anciently cultivated, 222–24; from Europe, 225–30; from Asia and Australia, 230–35; from Americas and Africa, 235–38; history of rose breeding, 238–40; dried saffron, 285; as fragrance materials, 452–53, 457–59, 458, 478. *See also* names of specific flowers
 “Flowers of the Air” (Müller), 77
 foie gras, 505
 forbs, 205–7, 206
 forest smells, 185, 207–9
 formaldehyde, 16, 17, 351: in woodsmoke, 412; from plastics, 428–29, 430; from building materials, 431; from combustion, 433; and toxic, 436, 446; from cooking, 493–94
 formic acid, 17, 46
 fossil organic materials, 12–14, 404–5, 419–24, 423. *See also* bitumen; coal; petroleum and petrochemicals
 fougère (perfume), 189, 478
 Fougère Royale, 478, 479
 Fox Run Vineyards, 571
Fragaria (strawberry) species, 160, 308–9, 310, 331
 fragrances, 441–83: incense, 443–46, 445–46, 482; incense-like tobacco, cannabis, moxa, 446–50, 449; methods for extracting natural volatiles, 450–57; materials from plants, 457–64, 458, 459, 460–61, 462, 464, 471–73, 472; materials from animals, 464–671, 469–70; synthetic materials, 473–77, 476; perfume notes and registers, 477–78; landmark perfumes, 478–81, 479–80; “listening to” incense and smells, 481–83. *See also* names of specific incense and fragrance materials and perfumes
fraise des bois strawberries, 308, 311
 Francis, Pope, 84–85
 frangipani, 235, 236
 frankincense, 185, 193–96, 194, 443–44, 445, 482
 Franklin, Benjamin, 99–100
 freesia, 235, 236
 Frobenius, August Sigmund, 436, 455
 fruit flies, 364–65, 592: wine taint, 575
 fruits, 295–335: as means of dispersing plant seeds, 139–40, 296; fleshy fruits as models for cooked foods, 296; importance of esters and lactones, 297–99; sulfur accents, 300–301; Tien Shan fruit forests, 302–3; apples and relatives, 303–5; cherries and relatives, 306–7; berries, 308–14; cucumber and melons, 314–16; tomatoes and relatives, 317–18; citrus fruits, 318–26; other subtropical and tropical fruits, 326–31; ginkgo as malodorous fruit premonition, 331–32; vanilla pod as fruit, 332; durian, 333–35; cooked fruits, 523–24; fermented foods, 569–75. *See also* names of specific fruits
 frying and fried foods, 387, 488, 490, 492–94, 412, 516
 fuels, 13–14, 21, 419–21, 422–24, 434. *See also* solvents and solvent-like smells
 fungi: kingdom of molds, mushrooms, and yeasts, 57, 341–44; and human skin, 110; and scalp, 113; suppressed by fruit volatiles, 298; decomposers and soil-makers, 343; distinctive volatiles, 349–52, 351; and dirty/spoiled smells, 351, 545–47, 545–46, 547; mushroom fruiting bodies, 353–57; and truffles, 358–62; in food fermentations, 550–51, 550–51. *See also* molds; mushrooms; truffles; yeasts

- furaneol, a furanone, 172, 173; in fruits, 299, 300, 309, 316, 317, 328, 329, 331; in cooking; 490, 525, 527; in cheeses, 567
- furanoeudesmediene, 194, 194, 445
- furanones, sweet carbon-oxygen rings, 172–73; in pandan leaf, 263; in mushrooms, 354, 356; in woodsmoke, 411; in sweet cooked bouquet, 490; in high-temperature cooking and smoking, 492–93; in cooked celery and lovage, 510; in bread crusts, 520; in dried fruits, 523; in brown sugars, 524; in baking, 528; in coffee, 529; in soy sauce and miso, 558–59; in wines, 573–74; in beers, 577. *See also* benzofurans/benzofuranones; furaneol; mesifuran; shoyu furanone; sotolon
- furans, carbon-oxygen rings, 411, 492–93, 512, 521, 523, 528, 572
- furfural, 200–201, 208, 345, 345–46, 411, 523, 584–85, 601
- furfurylthiol (“coffee mercaptan”), 529
- gajaichor, 340, 345, 367, 368, 481. *See also* petrichor/gajaichor
- galangal, 273, 273
- Galaxolide, synthetic fragrance, 476
- galbanum, 348, 461, 462
- Gallic rose, 238–39, 239
- game meats, xii, xiv, 505–6, 593–94
- garden compost, 345–47
- garden cress, 246, 246
- gardenia, 230, 234, 234, 465
- garland chrysanthemum, 227, 245, 245
- garlic, and garlicky smells, 182–84, 272; smells in urine and breath, 104, 105, 106; and allium family sulfur volatiles, 183; in garlic chive, 264; in petai bean, 278; in asafetida, 282, 283; in durian, 333; in mushrooms, 354–55; in truffles, 359, 360, 361; in swamp gases, 371; cooked, 512; in kimchi, 553, 554
- garlic family. *See* alliums, garlic family
- garlic parachute mushroom, 355
- gas: as invisible form of matter, 421; natural and fuel gases, 12–13, 44–45, 420–23; intestinal, 99–101; pyrolysis, 409–10
- gas chromatography-olfactometry (GC-O), xxvii–xxviii
- gasoline, 44–45, 405, 420–21, 423
- “Genesis of Petrichor” (Bear and Thomas), 339–40
- Genovese basil, 256, 256
- geosmin, soil smell, 348, 348–49, 349, 364; in beets, 270, 516; in fish, 390–91; in spinach, 514
- Geotrichum* yeast, 550
- geraniol, 168, 169, 254, 262, 273, 319, 321, 459
- geraniol, 167, 168, 229, 235, 442
- geranium, 167–68, 460, 460, 506–7, 517
- geranyl acetone, 111, 112, 171, 172
- Gerber, Nancy, 348
- German Research Center for Food Chemistry, 328
- Geruchsproben* (smell samples), 92
- Gesner, Abraham, 422
- Gewürztraminer wine, 571
- ghee, 498, 498
- giant kelp, 397–98, 399
- giant water bugs (*Lethocerus indicus*), 89–90, 90
- Gibson, James J., xxxi
- gillyflower, 228
- gin, 586, 587
- ginger, xxix, 140, 163, 170–71, 266, 268, 273, 273
- ginger family: aromatic roots, 273–74; cardamom, 290
- ginkgo, 135, 138, 331–32, 333
- Givaudan, 93, 121, 192
- gizzards, 505
- glues, 18, 160, 298, 414, 430, 432, 434
- GLVs. *See* green-leaf volatiles (GLVs)
- goat milk and cheeses, 78, 84–87, 500, 500, 565, 566
- goats, 84–87, 87: and carbon-chain names, 46–47; goatly smells in humans, 91, 120–22, 124, 126–27
- gochujang (fermented chili paste), 560, 560
- gooseberries, 312, 313
- Gorgonzola cheese, 567
- Gorillas in the Mist* (Fossey), 66
- Gouda cheese, 567, 568
- gourd family fruits, 314–16
- grain alcohols, 575–81; grain spirits, 588–89, 588. *See also* beer; rice wines; sake, rice wine; *names of specific spirits*
- grain-fed beef, 505–6
- grains, 274–77: cooked, 518–21; stale, 537–38, 538; fermented, 555, 557–60, 575–81. *See also names of specific grains and foods*
- Granny Smith apples, 297, 304
- grape hyacinth, 230, 231
- grapefruit, 319, 320, 324, 324, 459
- grapefruit volatiles, 170, 183, 301, 301: in armpit odor, 121–22; in wine, 571, 574; in beers, 577
- grapes, 313–14, 314: nitrogenous benzenoids and musky North American types, 175, 177, 298; sulfur-molecule accents in European types, 182, 301, 301; dried, 523; contribution to wine aromas, 570–72, 571–72. *See also* aminoacetophenone; methyl anthranilate; wines
- grass-fed beef, 505–6
- grasses and grasslands, 137, 154, 205–9, 206, 275, 407
- grasshoppers, 88, 89
- Gravenstein apples, 304
- Great Oxygenation Event, 33–34, 133–34
- Great Smog of 1952, 434
- Greek mints, 253, 253
- green beans and peas, 278, 514
- green bell (capsicum) peppers, 108, 181, 317–18, 514–15
- green lacewing, 89
- green-leaf volatiles (GLVs), 154–55, 186, 202; in primitive plants, 189; in conifer needles, 192; in leafy plants, 202, 206–8; in leafy vegetables, 243, 244–46; in herbs, 248–49, 257, 259, 261, 262–63; in fruits, 297, 304, 306, 313, 327, 329; in aquatic animals and plants, 382–83; in fragrance materials, 459; in olive oil, 496; cooked greens, 514
- green teas, xxv–xxvi, 542, 543–44
- green vegetables, cooked, 514–16, 515
- greens, edible, 242–65: leafy vegetables, 244–47; mint-family herbs and volatile diversity, 247–56; celery-family herbs, 256–59; daisy-family herbs, 259–60; American herbs, 260–62, 261; Asian herbs, 262–63, 262–63; cosmopolitan herbs, 263–65, 264; cooked, 514. *See also names of specific vegetables and herbs*
- Grew, Nehemiah, 258
- griddle cakes, 484, 528
- grilling and grilled foods, 61, 409, 491, 492–93
- Grojsman, Sophia, 480
- ground cherries, 317, 318
- grouse, xii–xiv, 56, 505, 593–94
- Gruyère cheese, 567, 568
- guaiaicol, 412, 413; in castoreum, 84; in woods, 201; in whole grains, 276–77; in woodsmoke, 412, 415; in fragrance tar extracts, 462; in toasted sesame oil, 495; in coffee, 529; in cured hams, 539–40; in wines, 572–73, 575; in barrel-aged spirits, 586. *See also* ethylguaiaicol; vinylguaiaicol
- guano, 68, 72–73
- guava, 329, 330: sulfur volatiles, 89, 183, 301, 301
- Guerlain, Aimé, 478–79
- Guerlain, Jacques, 480
- guided smelling, xxxi–xxxii
- Gulliver, Trevor, xii
- gums: chewing, 105, 166, 194, 264; trees, 194, 195, 445
- gut and its anaerobic microbiome, 64–67, 95–99
- Gwei-djen, Lu, 441
- gyokuro tea, 543, 544
- Haas, Paul, 376–77
- habanero chili, 318
- Haber, Fritz, 71
- Hadean Eon, 24
- Hades, 23, 36
- håkarl*, 387, 562
- halogen elements in oceans and ocean life, 374, 379–81, 380, 382, 393, 397–99; in whisky, 401–2; in onycha, 471. *See also* bromine; chlorine and chlorinated volatiles; iodine

- hams, cured, 539–40, 540
 Han China, 106
 hardwood trees and resins, 193–200,
 197, 199: smoke from, 414–15
 Hasegawa, Yoshihiro, 125
 hatcho or mame miso, 559
 hawthorn, 215, 216
 hazelnuts, 279–80, 280
 head and hair, human, 113–14, 114
 Hefeweizen beer, 578
 heliotrope, 237, 237, 247, 476
 heme, 502–3, 513
 hen of the woods mushrooms,
 356, 357
 Henderson, Fergus, xii
 heptadecatrienal, 383, 384, 399, 400
 heptanone, 311, 566
 herbs, 146, 202, 242–44, 247–65: in
 fragrances, 456–60, 478–80; dried,
 538. *See also* greens, edible; *names of
 specific herbs*
 Hero Carbon, explorer of complexity,
 38, 43, 49, 57, 69, 72: in plant
 chemical virtuosity, 131, 134–38,
 150; in flowers 210–12, 241; in herbs
 and spices, 268; discovered by organic
 chemists, 403–5, 424, 486; human
 partnership, 594–95
 herring, 389–90, 534, 562
 hexanal, 48, 155, 384, 385, 538
 hexane, 48, 420, 426, 455
 hexanoic acid, 19, 20, 47, 332
 hexanol, 45, 155
 hexenal, common green-leaf volatile,
 155: in insects, 89; and stale and
 rancid foods, 537, 538
 hexenol, 155, 384, 390, 393
 hexenyl acetate, 90, 155, 160, 239
 hickory nuts, 280
 highways of plant metabolism, 149–54,
 150, 153
 himachalenes, 170
 Hippocrates, 92
 hircinoic acid, 85
 ho wood, 462, 462
 Hofmann, August Wilhelm von, 427
 Hofmann, Thomas, 488
 hoja santa (“holy leaf”), 179, 261, 261
 holy basil, 255, 255
 hominy, 519–20
Homo erectus and *Homo sapiens*, 69,
 126, 407–8, 437, 536
 honey, xv, 88, 525, 526
 honeydew, 526
 honeydew melons, 315, 316
 honeysuckle, 229, 230
hongeo-hoe (fermented fish), 387, 562
 honjozo sake, 581
 hops, 264, 264, 576, 576–77
 horse excrement and stables, xv, xxv,
 67, 68, 79–80, 215
 horseradish, 152–53, 182, 271, 272
 horsetails, 189, 189
 hot springs, 10, 23, 25–27, 28, 36, 37,
 62, 489, 546
 household microbes, 545–47
 household smells, 142, 167, 175, 199,
 264, 379, 429–32, 442–43, 475,
 545–46
 “How to Talk about the Body” (Latour),
 xxxi–xxxii
 huacatay, 260
 huangjiu, grain wine, 580
 Huilliche people, 309
 “Human Sense of Smell: Are We Better
 Than We Think?” (Shepherd), xxx
 humulene, 170, 264
 humus, 347, 366
 Huysmans, Joris-Karl, 121–22
 hyacinths, 230, 231, 231–32
 hybrid tea roses, 240
 hydrocarbons, 13, 13–14, 39, 44,
 44–45, 47–49, 163, 366–67, 420,
 425–26, 431. *See also* fossil organic
 materials
 hydrogen, xxvii, 5–6, 8, 41: leavening
 gas in breads, 555–56
 hydrogen sulfide, 10, 14: primordial
 molecule, 21, 24; in volcanoes, hot
 springs, undersea vents, 26, 27, 28;
 ingredient in early life, 30–31;
 common product of anaerobic
 microbes but toxic to aerobic life, 35,
 401; and eggs, 36–37, 501, 541; and
 black salt, 37; from protein
 breakdown, 59; in anaerobic animal
 gut, 65, 67, 70–71; in anaerobic
 human gut, 95, 97, 99, 100–101; petai
 bean, 278; and struck-stone smells,
 368; from wetlands, 370; from wood
 pyrolysis, 409; from defective wall
 paneling, 432; in sulfurous bouquet of
 cooked smells, 490; in dirty/spoiled
 smells, 545; in wines, 572
 hydrosol, 451–52, 456, 457
 hydrothermal vents, 28–29, 37
 hydroxymethyl furfural, 345–46
 hydroxymethyl hexanoic acid, 120, 122
 hyraceum and hyrax, 470, 470–71

 ibn Masawaih, Yuhanna, 464
 idli, 555
 Imru’ al-Qais, 467
In Search of Lost Time (Proust), xiii,
 102, 229
 incense, 193–96, 199–200, 441–42,
 443–46, 445, 446
 indole, 61, 62: from protein breakdown,
 61; in excrement, 97; in malodorous
 flowers, 215; “dirty” notes in
 intoxicating flowers, 219–21; in
 daffodil, honeysuckle, lilac, lily,
 wisteria, jasmine, orange, tuberose,
 squash blossom, 226–38; in stinkhorn
 mushroom, 352; in milk, 499
 Indonesian cinnamon, 198
 indoor air, 430–32, 435, 436
 Indus River civilization, 273
 infusions, 264, 454–55
 injera, 555
 insects: successful animal group, 57,
 87–88; volatile secretions, 77, 88–90;
 evolutionary influence on plant
 volatiles, 137, 138–39, 140–41, 163,
 591–92; repelled by some plant
 volatiles, 142–43, 460; and GLVs,
 154–55; and terpenoids, 163, 253;
 and eight-carbon chains, 188; and
 conifer resins, 190–91; and flower
 volatiles, 214–19; hosts for
 fermentation microbes, 362, 549;
 targets of some yeast volatiles,
 364–65, 571; beeswax in perfumery,
 471; honey, 525–26; influence on tea
 aroma, 543; taints in wines, 575. *See
 also names of specific insects*
 interstellar molecules, 3–21, 10, 13
 iodine, 372, 374, 379–82, 396–98, 401
 iodoform, 380, 381, 399
 ionones, 171, 171: and violets, 225;
 osmanthus, 234; roses, 239; apricots,
 306; blackberries and raspberries,
 311, 312; papaya, 329; seaweeds and
 sea salt, 400; discovery of, 475;
 cooked carrots, 513; corn tortillas,
 520; teas, 543–44; capers, 554
 Irish moss, seaweed, 399, 399
 iron: likely role in early life, 30–31;
 production of metallic-smelling
 carbon chains, 350–51, 502–3; in
 ambergris maturation, 468;
 production of meaty volatiles in
 cooking, 502, 505; production of
 off-flavors in cooked fish and meats,
 507, 538; boosting of flavor in cooked
 crustaceans, 508
 iron sulfides: in black salt, 37; in rocks
 that produce struck odor, 368
 Islam, 467
 isobutyl methoxypyrazine, 181
 isolates, fragrance, 456, 481
 isoprene, 171, 171, 171: in human
 breath, 104–5; in plants, 171;
 large-scale emissions, 207–9, 345,
 401; in rubber latex, 428
 isopropyl alcohol, 41, 158–59
 isopropyl methoxypyrazine, 348, 349
 isothiocyanates, 182, 183, 271–72, 285,
 329, 516
 isovaleric acid, 59, 274

jamón ibérico de bellota, 540, 540
 jasmine flowers, xxii, 161–62, 211, 218,
 219, 220–21, 233, 233: in perfumery,
 452, 457, 458, 459, 479; jasmine
 aroma in tea, 543
 jasmine rice, 277, 277
 jasmolactone, 162, 162, 543
 jasmonoids, jasmone, jasmonic acid,
 161–62, 162, 167, 233
 Jellinek, J. Stephan, 477
 Jerusalem artichoke, 269, 269
 Jewitt, John, 535
 jiang, fermented condiments, 560
 Jicky (fragrance), 478–79, 479
 Jin Xuan tea, 543
 Jinhua hams, 540, 540
 jiuniang rice wine, 580

- Johnson, Arielle, 279
 Johnson, Samuel, 434
 jonquils, 226, 226
jukusei-ka, in aged sake, 581
 Juniper, Barrie, 303
 juniper: berries, 417, 586; tar, 462;
 trees, 191, 192, 319, 321, 446
junmai sake, 581
 Jurine, Louis, 100
- Kaiser, Roman, 192–93, 200, 473, 482
 kala namak (black salt), 37
 kale, 246, 246, 516
 Kanafani-Zahar, Aida, 450
 Kannauj, 481
 Kant, Immanuel, 212
 Kao Corporation, 125
kareishu (elderly smell), 112, 112
 karrikins, 407
 katsuobushi, 561, 563
 katsura leaves, 346
 Kekulé, August, 427
 Keller, Helen, 185, 207, 373
 kelp, 380–81, 397–99, 401
 Kenzo pour Homme (fragrance),
 480, 480
 kerosene, 420–24, 452
 kerosene tree, 196
 ketones, 15, 16, 17, 51, 65: and animal
 skin, 73; in cat urine, 81; and human
 skin, 111–14, 120; diacetyl, 112; plant
 benzenoids, 176–77, 180; raspberry
 ketone, 180, 311, 529; aromatic
 shrubs, 203–5; perilla ketone, 251;
 sulfanyl ketones in fruits, 301; in
 berries and citrus fruits, 311–13, 320;
 furanol, a ketone, 331; in
 mushrooms, 350, 357; from wetted
 stones, 366–67; in fishy smells, 385;
 solvents from plastics and building
 materials, 430, 431; in rose oil,
 458–59; synthetic, 476; in fatty
 cooked bouquet and cooked foods,
 489, 521, 529; in stale/rancid foods,
 536; in tea leaves, 543, 543–44; in
 dirty/spoiled smells, 545, 545–46; in
 fermented foods, 548, 551, 552; in
 blue cheeses, 566; in Cognac, 587.
 See also acetone; cat ketone;
 damascenone; diacetyl; filbertone;
 furanol; geranyl acetone; heptanone;
 ionones; methyl heptenone; raspberry
 ketone
- key limes, 321
 khao mahk, rice wine, 580
 Kilaua, 26
 kimchi, 553, 554
 King, Anya, 467
 king mushrooms: bolete, 353, 356, 356;
 oyster, 354, 355
 kinome, 262, 262
 kitchen greens and herbs. *See* greens,
 edible; herbs; *names of specific greens*
 and herbs
 kitchen sink and
 drain, 545
- kitchen smells from microbial growth,
 545–46
 kiwifruit, 297, 312, 313
 koji, 552, 558, 581, 589
 kombu, 398, 399
 kombucha, 550, 583–84, 585
 konjac, 215, 216
 Kraft, Philip, 466, 477
 kumquats, 325, 325
 Kuriwaki, Mio, 482
- La Brea Tar Pits, 419
 LAB. *See* lactic acid bacteria (LAB)
 labdanum, 448, 461, 462, 471
 lacewings, 217
 lactic acid: skin secretions and diacetyl,
 110, 112
 lactic acid bacteria (LAB), 548–49:
 human skin microbiome, 116; in food
 fermentations, 548–49, 553, 558,
 561, 562, 564–68; in wine, 572; in
 beer, 579; in sake, 581; and evolution
 of flowers and fruits, 592. *See also*
 Lactobacilli; *Lactococcus*
Lactobacilli, 116, 549, 567–68
Lactococcus, 549
 lactones, 160–61: in scalp and hair,
 113–14; oak/whiskey lactone, 201; in
 nuts, 280–81; in fruits, 299–300,
 299–300, 306, 309, 316, 317, 323,
 329, 331; in woodsmoke, 410, 412; in
 animal fats, 488–89, 497–98, 498,
 505; in coconut oil, 497; in milk and
 dairy products, 499–500, 499–500,
 527, 564–65; in syrups, 525; in tea,
 543; in wine, 571, 573, 574; in
 barrel-aged spirits, 586. *See also*
 decalactones; jasmolactone; maple
 lactone; whiskey or oak lactone; wine
 lactone
- ladybug taint, in wine, 575
 ladybugs, 88, 88, 575
 Lagavulin whisky, 402
 lager beers, 577, 578
 Lake Avernus, 23, 27, 36
 lamb, 84–87, 87, 504, 504
 Lamb, Charles, 330–31
 Lambert, Jordan, 106
 lambic beers, 579, 579
 land plants. *See* plant kingdom and
 plants
 lanolin, 78, 86–87, 87
 laozao, fresh rice wine, 580, 580
 lard, 497, 498
 Latour, Bruno, xxxi–xxxii, 443
 Laudan, Rachel, 397
Laugengebäcke (lye-baked goods), 521
 laundry, 74, 442, 473, 475, 480,
 536, 546
 laurel tree family, 196–98, 197, 288–89
 lavender: flowers, 227, 228; mint-family
 herb, 248, 251, 251, 253; in fragrances
 and perfumery, 459–60, 460,
 478, 479
 laver, 398, 399
 Lawrence, Joseph, 106
- “Le Gousset” (Huysmans), 121–22
 leaf litter, 343, 345–46, 353
 leafy plants, 202–3
 Leal, Walter, 569
 leather, 470
 Lebanon cedar, 191, 192
 leeks, 183, 511, 512–13
 legumes, 277–78, 514, 522
 Leibniz Institute for Food Systems
 Biology, 487–88
 lemon, 319–21, 321: lemony terpenoids,
 168, 168, 169
 lemon basil, 255, 255
 lemon mint, 252, 253
 lemon thyme, 254, 254
 lemon verbena, 261, 261
 lemongrass, 262, 262: and ants, xxix,
 126, 140, 162
 lenthionine, 354
 lettuce, 244–45, 245
 lettuce basil, 255
 lichens, 342, 461, 461
 licorice, 273, 274, 274
 lighter fluid, 21, 45
 lightning and ozone, 11, 367
 “lightstruck” stale smells, 538, 579
 lignin, 135, 137: plant metabolic
 highway, 151, 153; byway volatiles,
 173–80; volatile fragments in tree
 woods, 201, 601; fragments from
 pyrolysis and combustion, 411–15;
 fragments in beaver castoreum, 470;
 and meat aroma, 504; and old
 books, 601
- lilac alcohols and aldehydes, 229
 lilac flowers, 229–30
 lilies, 211, 222–23, 225–26, 231–32
 lily of the valley, 225, 226, 476, 479
 Limburger cheese, 114, 116, 127, 550,
 566, 567
 limes, 164, 320, 321; makrut, 325
 limoncello, 454
 limonene, 168, 169, 208, 217, 258, 281,
 319, 345, 442
 limu, Hawaiian seaweeds, 397, 398,
 399, 399, 400
- linalool, 167–68, 168: and ho tree, 198,
 462; in flowers, 217, 219, 220, 229,
 235, 237; in mints and basil, 253,
 255–56; in ginger and coriander and
 cinnamon, 273, 282, 289; in stone
 fruits and berries and grapes, 306,
 311, 314; in citrus fruits, 322, 324; in
 papaya, 329; industrial production,
 442; in fragrance materials, 460, 462;
 in coffee, 529; in capers, 534
 linalyl acetate, 169, 169, 326, 460
 linden ether, 229, 510
 linden tree and flowers, 229, 230
 lipids, source of volatile fragments, 40,
 57, 151: pet skin, 73, 75, human skin,
 111–14, 120; plant “skin” materials
 and volatile byways, 151, 152,
 154–62, 169–70; in ambergris, 468;
 and fatty cooked bouquet, 488; and
 meaty flavors, 502, 505–6, 539; stale

- and rancid smells, 536, 538; dirty smells, 546; old books, 601
- liquamen, 561
- liquid smoke, 407, 425–26
- “listening to smells,” 481–83, 595
- Lister, Joseph, 106, 426
- litichis. *See* lychees
- liver: role in metabolism, 94; cooked, 505–6
- liverworts, 140–41, 188–89, 189
- lobster, 386, 508, 508
- lobster horn red alga, 376–78
- long pepper, 286, 287
- lotus flower, 211, 223, 224, 224
- lovage, 257, 257, 510–11
- Lucretius, 22, 23
- Lundström, Johan, 125–26
- lychees, 163–64, 167, 328, 328, 571
- lycopen, 316, 324, 329
- Mabberley, David, 303
- MacDiarmid, Hugh, xvii
- mace, 289, 290
- mâche, 247
- macrocyclic musk molecules, 465–66, 466, 467, 469, 471–75: in leaf litter, 345; in tobacco, 448
- Madeira wine, 573, 574
- madeleine (small cake), xiii, 229
- Madonna lily, 223
- magazines, 431, 432
- Magendie, François, 100
- Maggi brand seasoning: and Maggi-pilz mushroom, 356, 356; and cooked lovage, 511–12
- magnolia flowers, 235, 236
- mahleb, 284, 284–85
- maidenhair ferns, 189, 189
- Maillard reactions in cooking, 489–91, 531–32
- maitake mushrooms, 356, 357
- maize. *See* corn (maize)
- makgeolli, 580
- makrut lime, 262, 262, 325, 325
- Malay Archipelago, The* (Wallace), 295
- malt and malting, 576: malt syrups, 276, 525; and beer aromas, 576, 578; and whiskies, 588; malt vinegar, 582
- maltol, 490: in fallen cake-tree leaves, 346; in caramel, 486; and sweet cooked bouquet, 490; in tea smoking, 493; in cakes and cookies, 528; in beers, 577
- mame miso, 559
- mandarins, 320, 322–23, 323
- mangoes, 279, 327–28, 328
- manuka honey, 526
- manure, xxii, xxiii, xxviii, 11, 59, 69–72, 86, 347, 353, 564. *See also* excrement
- maple lactone, 525
- maple syrup, 172–73, 284, 525, 525
- maple trees, 200–201, 201
- Mapuche people, 309
- Mara des Bois strawberries, 311
- Marggraf, Andreas, 474
- marigold, 227, 227, 235–36, 236
- marijuana. *See* cannabis (marijuana)
- marjoram, 251, 251
- marking pens, 59, 414, 431–32
- marzipan, 178, 279
- mastic, 194, 194
- matcha tea, 543, 544
- Mathieu, Christian, 480
- matsutake mushroom, 357, 357
- McBurney, Donald, 125
- meadowsweet, 225, 225
- meat extracts, 503–4
- meat stews, 512–13
- meats, and meaty smells, 501–6: and grouse experience, xii–xiv, xxiv, 56, 593–95; game meats, xii–xiv, 505–6, 593–95; cured or fermented meats, 534–35, 539–40, 562, 563. *See also* names of specific meats
- meats, fermented, 562–63
- meaty bouquet, 502–4
- Mediterranean region: flowers of, 215, 221, 223, 223–24; adaptations of herb plants, 247–49, 260; and mint-family herbs, 249–51, 252–54
- Mefite, 36
- meju* fermentation starter, 552
- melons, 314–16: melon volatiles in seafoods, 382–84
- memory and smell, xxiii–xxiv, xxxi–xxxii, 126, 362, 483, 485, 596
- menthatriene, 165, 165
- menthenethiol, 183
- menthol, 106, 142, 144–45, 166, 166, 249, 250, 252
- mephitic smells, 36
- mercaptomethyl pentanol (MMP), 513, 513–14
- mesifuran, 172, 173, 309
- metabolism: and life's common starter-set volatiles, 39–40; animal metabolism, 57–58, 60; microbial metabolism in animals, 64–65, 74; human metabolism, 93–95, 101–3, 104–5; microbial metabolism in humans, 94–99, 105–6, 110; plant metabolism and volatile production, 149–54; microbial metabolism in fermentations, 535
- metallic smell, 120, 122, 350–51, 388, 393, 489: in staleness and rancidity, 275, 536; in blood and meats, 350–51, 502–3, 503, 505–6, 538
- meteors and meteorites, 18–20, 25
- methane, 13, 15, 45, 71, 348, 371, 420
- methanethiol, 14: primordial, 14, 21; signal of rot, 36; in animal malodors and excrement, 59, 67, 68; product of anaerobic metabolism, 65; in human malodors, 95, 100–104, 105; from wetlands, 370; in sulfurous cooked bouquet, 490; in light-struck milk, 538; in fermented foods, 548, 549, 550, 555
- methanol (methyl alcohol), 17, 158–59, 208, 345
- methional, 490: in mushrooms, 353; in truffles, 360–61; in sulfurous cooked bouquet, 490; key in cooked potatoes, 516; in soy sauce and miso, 558; in cheeses, 563
- methoxyprazines, 181, 192, 278, 348, 514, 516, 529; in wines, 571, 572, 575
- methyl: in chemical structures and names, 13, 19, 51. *See also* terms beginning with “methyl”
- methyl acetate, 17, 18
- methyl alcohol, methanol, 17, 158–59, 208, 345
- methyl anthranilate, 175, 180, 181, 182, 219, 298, 299, 309, 311, 314, 458, 475
- methyl butyrate, 157, 299
- methyl eugenol, 179, 180
- methyl furanethiol (“fish thiol”), 507, 509: in coffee, 529; in meats, 540; in soy sauce, 559; in wine, 573
- methyl heptenone, 111, 112, 280
- methyl jasmonate, 161, 162, 458, 543
- methyl salicylate, 143–44, 174, 174–75, 217, 219, 264
- methyl sulfanyl butanol, 81, 121, 122
- methyl sulfanyl pentanone (“cat ketone”), 81, 204, 264, 301, 324, 325, 328
- methyl thiopentane, 368
- methyl tridecanal, 497, 512–13
- methylamine, 11, 15, 61
- methylbutanal, 491: in black truffles, 360; key to nutty cooked bouquet, 491; in malted barley, 525, 576; in cocoa and chocolate, 530, 531, 532; in soy sauce and miso, 558–59; in rice wines, 580–81
- methylbutanol, 327, 363, 592
- methylbutyl (isoamyl) acetate, 157, 299, 327
- methylbutyric acid, 19, 51, 59, 74, 274, 531
- methylisoborneol (MIB), 348, 349, 390–91
- Mexican: basil, 255, 255; cedar, 192; limes, 321, 321; oregano, 261, 261; tea, 260
- Meyer lemons, 321, 321
- mescal, 590, 590
- microbes and microbiomes: and early evolution of life, 27–29, 31–34; ubiquitous sources of volatile molecules and smells, 29; oxygenation of Earth's atmosphere, 34–35; anaerobic and aerobic lifestyles, 34–35; and life's starter set of volatiles, 39–44; and animal smells, 58, 61, 63, 64–68, 74–75, 81–82, 86–87, 465, 467, 468, 504; human commensals, 95; gut microbiome, 96–99; mouth microbiome, 104–8; skin microbiomes, 110, 113, 114–15, 116–18, 119–20, 125–26; plant defenses against, 136–37, 163, 190, 200; in soil and compost, 340–41,

- microbes and microbiomes (*cont.*)
 342–44, 345–49, 366–67; in truffles, 359, 362; in wetlands, 370–71; and ocean phytoplankton, 375, 378; and fishy smells, 386–87; and sea salts, 400; and fossil organic materials, 405–6; and biotechnology, 476; and fermented foods, 534–35, 548–52; and household malodors and spoilage, 545–47; and evolution of delightful smells, 591–92. *See also* bacteria (microbes); cyanobacteria; decomposition; excrement; fermentation; fungi; urine; *names of specific microbes*
- Mieze Schindler strawberries, 309
- Milbenkäse (mite cheese), 569
- mild hardwood trees, 200–201
- mildew, 351. *See also* molds
- milk chocolates, 531
- milks: human breast and formula milks, 95–96, 124, 299; goat and sheep, 86, 87; cow, 499; water buffalo, 565; and lactones, 161, 488; cooked, 488, 490, 499–500; stale and spoiled, 538, 547; fermented, 563–69. *See also* butter; cheeses; creams, cow milk; sour cream; yogurt
- Milton, John, 131–32, 146, 185, 193, 195, 247
- mimolette cheese, 569, 569
- mimosa flower, 234, 235, 476
- mineral spirits, 422–23
- minerality, 23–24, 340, 367–69, 369, 572. *See also* petrichor/gaiaichor; stones
- mint family of herbs, 247–56: volatile defenses, 247–49; common family members, 249–52; uncommon mints, thymes, basil, 252–56. *See also names of specific herbs*
- minty smells: minty plant terpenoids, 166–67; peppermint menthol, 166; spearmint carvone, 167, 250, 254; in manufactured products, 106, 142–43, 144–45, 442; in palo santo wood, 200; in mint-family herbs, 251–54; as tobacco flavoring, 448
- miso, 559, 559
- mitti attar, 481
- MMP (mercaptomethyl pentanol), 513, 513–14
- moist cooking methods, 492
- molasses, 524, 524, 591
- molds, 57, 332: and kingdom of fungi, 341–44, 349, 351; in curing and fermentation, 540, 544, 551; and moldy, dirty/spoiled smells, 545–47; in Asian fermentation starters, 552, 558, 579–80, 581; Asian seed condiments and katsuobushi, 558–60, 561; salami, 562; mold-ripened cheeses, 566; Asian rice wines, 579–81
- molecular clouds, interstellar, 8
- molecular senses, xxiii
- molecules, xvi–xviii, xx: and smells, xxi–xxiii; identifying, xxvi–xxvii; formation and detection between stars, 7–9
- mollusks, 376, 392–96; cooked, 508–9, 509
- Monell Chemical Senses Center, 112, 125–26
- monosodium glutamate (MSG), 398
- monoterpenoids, 164–69: minty, 166–67; floral, 168; and conifer trees, 191–92; and aromatic hardwoods, 198, 199; in turpentine, 431; in fragrances, 458, 462, 478; and wines, 571. *See also names of specific monoterpenoids*
- morel mushrooms, 357, 357
- moss roses, 240, 241, 248
- mosses, 135, 140–41, 188–89, 189, 341
- mothballs, 14, 219–20
- moths, 141, 217–19
- Mount Etna, 26
- mouth: of pets, 74; human, 104–8, 124; and aroma creation, 107–8, 531, 575. *See also* breath
- mouthwash, 105–8, 142, 143, 250, 260, 289. *See also* breath
- moxa, 449, 449–50
- mozzarella cheese, 565, 566
- muddy smells in fish, 390–91
- mugwort, 204, 245, 245, 449–50
- Muhammad, Prophet, 467
- Müller, Fritz, 77, 141
- mummification, 143, 191, 418–19
- Munster cheese, 566, 567
- Murchison meteorite, 19–20
- Murdoch, William, 421–22
- murri, 558
- muscadine grapes, 175–76, 182, 313–14: wine, 572
- muscat grapes, 313–14: wine, 571
- muscone, 84, 466, 474
- mushroom alcohol, 350. *See also* octenol
- mushrooms, 43, 57, 341–44, 349–62: and basic carbon chains, 43, 156, 350–51, 382–83; cultivated varieties, 353–55; “wild” symbiotic varieties, 355–57; cooked, 516–17. *See also* fungi; truffles; *names of specific mushrooms*
- mushroomy-musty smells, 89, 350–51, 545, 546, 551, 557
- musk, deer signaling secretion, 82–84, 83, 467: as fragrance material, 450, 454, 464–65, 466–68, 469; plant-derived alternatives, 471–73, 472; synthetic alternatives, 473–75, 476; in perfumes, 478–80. *See also* ambrette; macrocyclic musk molecules; musk xylene; nitromusks
- musk ox, 85
- musk rose, 238–39
- musk strawberry, 309, 310
- musk xylene, 474
- muskmelons, 299, 316
- mussels, 395, 396, 509, 509
- mustard, greens and seeds, 152–53, 182, 246, 246, 267, 271, 285–88, 287, 515, 516
- mutton, 87, 504
- mycelium, 341, 359
- myrcene, 165, 194, 217, 264, 322, 417
- myristine, 179, 180
- myrrh, 185, 193–96, 194, 445, 451
- nam pla, 561, 562
- naphthalene, 13, 14, 88, 420, 421, 431, 449, 472, 571
- naphthas, 422–23
- nard, 463, 464
- nasturtium, 246
- natto, 545, 556, 557
- natural gas (methane), 12–13, 45, 71, 370, 419–20, 423
- Natural History* (Pliny), 210, 266, 339, 417
- “Nature of Argillaceous Odour” (Bear and Thomas), 339–40
- naval stores, 417–18
- Neanderthals, 415–16, 425, 513
- nectar, 138, 175, 216–17, 362, 471, 525
- nectarines, 306
- Needham, Joseph, 441
- neptella, 250, 250
- neral, 168, 169, 254, 262, 273, 319, 321, 459
- nerol, 167, 168, 229
- neroli (orange blossom), 326, 458, 458, 526
- nerolidol, 171
- Neurogastronomy* (Shepherd), xxx
- new-car smell, 432
- newspapers, 201, 431
- nicotine, 137, 446–48
- nigella, 284, 284
- night-blooming cereus, 237, 238
- night flowers, 219, 223, 233, 237
- nightshade plant family, 317–18, 318, 447
- nihonshu, sake, 581
- nitrogen, element in volatile molecules: primordial molecules and distinctive smells, 11, 14–15, 20, 25; in amino acids, proteins, and purines, 57–59; in volatile products of metabolism, 60–62, 62; and animal death, 63; and animal excrements, 67–72, 79; in products of human metabolism, 93–94, and human excrements, 97, 99, 102–3; in sexual secretions, 117–18; and plant metabolism, 151, 152–53; in plant volatiles, 175, 177, 180–82; in flower volatiles, 215, 219–20; in soils, 347; in gaiaichor, 367; in sea animals and algae, 386–87; in tobacco, 447–48, in animal-derived fragrances, 467, 469–71; and synthetic musks, 473–74; and cooked smells, 491–93. *See also names of specific molecules*
- nitromusks, 474, 479

- nitrophenols, 367
 nitrosamines, 99
 nixtamal, 519–20
 noble rot, wines, 574
 nonadienal, 382
 nonanoic acid, 49, 367
 nonenal, 112, 142, 314, 384, 536, 539
 nonfat dry milk, 500, 500
 non-smell volatile qualities, 143–47
 nootkatone, 170, 319, 324
 nori, seaweed, 398, 399, 517–18, 518
North Atlantic Seafood (Davidson), 533
 nuoc mam, fish sauce, 561
 nutmeg, 289, 290
 nuts, 161, 278–81, 302: cooked, 518, 519; stale, 537–38, 538
 nutty cooked bouquet, 491, 491
- oak trees and wood, 200–201, 201:
 charred, 410, 412; wine barrels, 572–73
 oakmoss, 461, 461, 478
 oats, 276, 276
 ocean smells, 372–74, 379–80
 octanal, 45, 111, 350, 351
 octane, 45, 420, 426
 octanoic acid, 47, 48, 499, 570
 octanone, 351, 353–54
 octenol, 156, 350: in fungi/mushrooms, 350, 351, 353–54, 357, 364; and aquatic creatures, 384, 390, 394, 396, 399; and cooked food smells, 489, 497, 522; in stale smells, 537, 547; in dirty household smells, 546; in fermented foods, 553
 octenone, 350–51, 384, 505
 octopus, 395–96, 396, 508–9
 office printer, 11, 431
 ogo, seaweed, 399, 399
 oils. *See* fats and oils; petroleum and petrochemicals
 okra, 515, 515
 olfaction, sense of smell, xxvii–xxxii
 “Olfactory Comfort in Close Relationships: You Aren’t the Only One Who Does It” (McBurney), 125
 olibanic acids, 193, 193–94, 478
 olibanum, 193–94, 194, 445
 olives and olive oil, 121, 451, 496, 537, 538–39, 554, 554
On the Erythraean Sea (Agatharchides), 185
On the Nature of Things (Lucretius), 22
 onions, 10, 81, 100, 121–22, 126, 152, 183, 272, 272, 490, 511, 511–13. *See also* alliums, garlic family
 onsen eggs, 36
 onycha, 470, 471
 oolong (wulong) teas, 162, 543, 544
 orange blossom/flower, 220, 234, 235:
 water, 458; honey, 526. *See also* neroli (orange blossom)
 oranges, 320, 322–23, 323: Proust on, xiii–xiv; and terpenoids, 168–69, 169; peel essential oils, 453, 459; marmalade, 523
- orchids, 224, 224, 237, 238, 292
 oregano, 165, 248, 250, 251:
 Mexican, 261
 Oregon truffles, 361, 361–62
 organic chemistry, 403–5, 427–28:
 and chemical isolation of volatiles, 424–27; and man-made polymers, 427–33; and fragrances, 473–77
 organic matter, 10, 71, 347, 404, 419–21, 427, 545, 548: fossil, 419, 427
 “Oriental”: fragrances, 480; lily, 231, 232; storax, 195; tea, 543; tobaccos, 448
 origins of life, 27–29
 orris root, 464, 464
 Orwell, George, 123
 osmanthus, 234, 234, 458, 458–59
 osmocism concept, xi–xii, xv–xvi, xvii, 39, 592
 Osmothèque fragrance conservatory, 481
 oud. *See* agarwood
 Ovid, 120–21
 Owakudani, Japan, 36
 oxidation, 33, 43: on animal skin and hair, 73, 87; on human skin and hair, 111, 112, 113, 114, 120; and stale and rancid smells, 279, 499, 536–39; and petrichor/gaiaichor, 367; and aquatic smells, 380–81, 385, 388, 393; and combustion, 408; and cooked smells, 488; and aged wines, 573–74. *See also* Great Oxygenation Event; oxygen
 oxygen: chemical element, 6, 8, 11; in primordial carbon chains, 15–20; and energy production in living things, 29, 32–34; and photosynthesis, 32–33; oxygenation of Earth’s atmosphere, 34–35, 133–34, 406; in starter-set volatiles, 39–50; and fire, 406, 409; and meat volatiles, 502; and wine aging, 573; and vinegar, 582. *See also* aerobes; anaerobes; Great Oxygenation Event; oxidation; photosynthesis
 oyster mushroom, 343, 354, 355
 oyster plant, 246, 247
 oysters, xiv, xxvi, 372, 382, 386, 392, 393–94, 395, 509, 509
Oysters of Locmariaquer, The (Clark), 372
 ozone, 10, 11, 34, 367, 401
- packaged dry yeast, 555
 paint thinners, 405
 palm oil, 496, 497
 palo santo (“holy wood”), 200, 446
 pandan leaves, 181, 263, 263, 277, 514
 Pangaea, 134, 138
 papayas, 329, 330
 paperwhite flowers, 226, 226
 Paracelsus, 473–74
- Paradise Lost* (Milton), 131–32, 193, 247, 301
 paraffin, 45, 422–23, 431–32
 Parmesan cheese, xiv, xvii, 115, 539, 568–69
 Parquet, Paul, 478
 parsley, 258, 259: root, 270, 270
 parsnips, 270, 270
 passion fruit, 183, 301, 329, 330
 Pasteur, Louis, 34–35
 pasteurization, 499
 pastries, 527–28
 patchouli, 460, 461
 patchoulol, 460
 Pater, Walter, 296
 peaches, 113, 161, 224, 224, 303, 306
 peanuts and peanut oil, 277–78, 278, 495, 496
 pears, 215, 216, 303, 305, 305, 587, 588
 peas, 278, 514, 515
 peat, 402, 408, 588
 pecans, 280, 281
 pecorino romano cheese, 568, 569
Penicillium molds, 344, 349, 551, 552, 561–62, 566
 pennyroyal, 253, 253
 peppermint, 187, 249, 250, 252–53
 peppers and peppercorns, pungent spices, 170, 266, 285–88, 287–88, 459
 perception, of smells, xxiii–xxvi, xxviii–xxxii
 perception at second hand (Gibson), xxxi
 perflavory.com database, 142, 147
 perfumery and perfumes, 441–42, 450–51, 477–81, 479–80: methods to extract and concentrate volatiles, 451–57; plant flowers, fruits, leaves, 457–61; plant resins, woods, roots, 461–64; animal materials, 464–71; plant musks, ambers, 471–73; synthetic materials, 473–77; notes and compositions in, 477–78; landmark compositions, 478–81; exploring, 481–83. *See also* fragrances; names of specific perfumes and materials
 pericón, herb, 260, 260
 Périgord truffles, 360, 360
 perilla (shiso) and perilla aldehyde, 166, 167, 227, 251, 252
 perique tobacco, 448
 Persia, medieval: and flowers, 233–34; and melons, 315; and fragrances, 452, 457, 464, 467, 469
 Persian limes, 320, 321
 persimmon, 307–8, 308
 perspiration, 103, 109, 546. *See also* body odors; sweat; sweaty-smelling volatiles
 pet smells, 56, 73–76. *See also* cat urine
 petai bean, 278, 278
 petitgrain (sour orange leaf), 326, 460, 460

- petrichor/gaiaichor, 339, 340, 366–67, 367
 petroleum and petrochemicals, 12, 164, 403–5, 418–21, 421, 422–24, 432–36
 petunia, 236, 237
 Peynaud, Émile, 107–8, 571
 phenol, **20**, **413**, 414, 426: in meteorites, 20; from protein breakdown, 59; in excrement, 67; in creosote bush, 205; in mushrooms, 354; in sea urchin, 397; and plastics, 428–29; in coffee, 529; in sufu, 557; in cheese, 566. *See also* phenolics and phenols
 phenolics and phenols, 413: in excrement, 71, 97; in pet smells, 74; castoreum, 84, 469; in mouthwash, 106–7; in whole grains, 276, 518, 520, 522; in truffles, 360; and “brett” aroma in beer and wine, 365, 572, 579; in peat and whiskies, 402, 588; in smoke, 410, 414, 415: in tobacco, 448–49; in oakmoss, 461; in birch tar oil, 462; in animal fragrance materials, 471, 478; in meats, 504; in potato skins, 516; in coffee, 529–30; in katsubushi, 563; in smoky wine taint, 575; in beers, 577, 578, 579. *See also* cresols; nitrophenols; phenol
 phenyl ring molecules, 175–78, 176
 phenylacetaldehyde, 175, 176, 219, 223, 269, 276, 490, 526
 phenylacetic acid, 20, 175
 phenylalanine, 153, 174, 175
 phenylethanol, 175, 176: and flower scents, 217, 219, 229, 237–38, 456–57; and yeasts, 363, 592; and rice wines, 580
 phenylethylamine, 181, 182
 pheromones, 79, 85–86, 88, 398
 philodendron, 141, 214
 Phoenicians, 416
 phosphine gas, 371
 photosynthesis, 31–33: and oxygenation of Earth’s atmosphere by microbes, 33; and rise of plant kingdom, 132, 134–35; and plant chemical creativity, 135–36; and plant volatiles related to light gathering, 150, 151, 163, 171, 350; in plankton and seaweeds, 375–76, 397; and fire, 406
 phthalides, 257, 269, 281, 510
 phytoplankton, 375–78, 381, 383, 392–93, 395, 400
 pickled foods, 272, 548, 552–54, 553–54. *See also* fermentation
 pigs, 67, 68, 101, 214, 215, 497, 504, 539
 pine mushrooms, 357, 357
 pine nuts, 279, 280, 537
 pine tree, 134, 192, 192, 194, 208, 279, 345, 415, 417: and turpentine, 143, 191, 417–18; sunstruck resin, 192–93, 473
 pineapple, xiv, 154, 157, 160, 309, 330, 330, 331, 486
 pineapple guava, 329, 330
 pineapple ketone, 331
 pineapple mint, 253
 pineappleweed, 235, 236
 pinene, 164, **165**: in conifer forests, 171, 208, 345; in flowers, 217; in ginger, 273; in citrus fruits, 320; in conifer resins and turpentine, 417
 piney smells, 134, 137, 143, 152, 164, 165, 192, 192, 198: and citrus peels, 319; synthetic 442, 594; fragrance notes, 478
 pink oyster mushroom, 354, 355
 pink peppercorns, 288, 288, 459
 pinks (flowers), 228
 piperine, 286. *See also* peppers and peppercorns
 pisco, 587, 587
 pistachio nuts, 279, 280
 pitch, 417, 435
 plankton, 375–78, 381, 383, 392–93, 395, 400, 402, 509
 plant kingdom and plants, 57, 131–34: evolutionary advantages and chemical virtuosity, 134–36; and challenges of defense and reproduction, 136–41, 212–13, 216–19, 247–49; metabolic highways, 149–54; volatile families, 154–84; forests and grasslands, 207–9; edible, 242–335; and soil, 340–41, 354–47; source of fermentation microbes, 362, 548–51; and petrichor/gaiaichor, 367; and fossil organics, 404–5, 418–20; and fire, 406–7; and fragrances, 441–50, 457–64, 471–73, 472. *See also* algae; seaweeds; *names of specific plants, plant parts, and plant materials*
 plant musks and ambers, 471–73, 472
 plant oils (cooking), 495–97, 496, 497
 plantains, 304, 327, 328
 plastics, 12, 195, 305, 378, 427–33, 430. *See also* petroleum and petrochemicals
 Pliny, 143, 212, 266–67, 339, 366, 496
 plums, 303, 306
 POF (phenolic off-flavor), 578
 polenta, 519
 pollen and pollination, 138, 140–41, 212–17, 218–19, 220, 332, 349, 592
 pollutants, 207, 209, 433, 443
 polycyclic carbon rings, 14, 465–66, 471–72, 475, 476
 polyethylene, 428, 429, 434
 polymers, 428, 429, 430
 polystyrene plastics, 195–96, 428, 430
 pome fruits, 303–5, 304–5
 pomegranate, 307, 308
 pomelos, 320, 323–24, 324
 pompona vanilla, 293, 293
 popcorn, 519, 520: smell, 181, 263, 277, 396, 508, 521, 527
 porcini mushroom, 343, 356, 356
 pork, 67, 498, 504, 504, 512–13, 513
 potatoes, xxi, 269, 269, 516, 517
 Pott, Percivall, 434
 pre-amino benzenoids, 174–75, 175
 preservatives, 17, 195–96, 418–19, 553, 558
 preserves, fruit, 523, 524, 526
 pressure cooking, 492
 pretzels, 521, 522
 primordial molecules and smells, 10–21
Problemata, 55, 91, 92, 105, 119
 Proctor, Robert N., 446–47
 proline, 62, 392, 508
 propanal and propanaldehyde, 16, 17
 propane, 45, 409, 420
 propenal (acrolein), 16, 17, 21, 412, 495
 propenyl carbon chain, 412
 propenyl sulfides, 511–12
Propionibacterium, 120, 549, 550
 propionic acid, 19, 20, 41, 59, 95, 97–98, 115, 370, 555, 567
 propyl alcohol, 158–59
 propyl carbon chain, 412
 prosciutto, 539, 540
 proteins: and eggy hydrogen sulfide, 36, 501; and animal smells, 57–58, 502; characteristic breakdown molecules and smells, 58–62, 59, 60, 62; and death smells, 63; in excrement, 67–68, 97–98; in mouth and breath, 74, 105–6; in urine, 80, 101–4; in sheep and goats, 86–87, 504; on feet, 115; and sexual smells, 117; in armpits, 120–21; in cheese, 127, 561, 566, 568; and plant volatiles, 151–53, 180–84; in compost, 347; in seafood, 386–87; in tobacco, 447; in animal fragrance materials, 465; in cooked foods, 489–90, 493, 504, 525, 529, 532; in cured and fermented foods, 539, 543, 556–60, 561. *See also* amino acids
 Proust, Marcel, xiii–xiv, 102, 229, 594
 prunes, 523, 523–24
Pseudomonas aeruginosa, 75, 75, 547
Psychoanalysis of Fire, The (Bachelard), 484
 pu-erh teas, 544
 puff pastry, 527
 pulegone, 166, 250
 pumpkins, 517: seeds, 518, 519
 pungent roots and bulbs, 271–72, 272
 pungent spices, 170, 266, 285–88, 287–88
 purines, 58, 60, 62, 63, 93, 97, 101
 putrescine, 60, 62, 62–63, 74, 105, 117
 putrid smells, 60–63, 66, 74, 79, 97–98, 105, 117, 333–34, 347, 352, 490, 501, 534, 547, 553, 591
 pyrazines, nitrogen volatiles, **181**, **182**: in insects, 88; in plants, 181; in celery family, 259; in root vegetables, 269; in soil, 348, 349; in cooked foods, 492–93, 518, 521, 529; in chocolate, 530; in tobacco, 447–48; in fermented foods, 557; and vinegar aromas, 584–85
 Pyrgos, 451–52
 pyridines, **20**, 447–49, 470, 472, 530

- pyrolysis, 408–10; and smells of fire and smoke, 411–15; useful products of wood pyrolysis, 415–18; and petrochemicals, 418–21; toxic volatiles from, 434–36, 446; incense and tobacco, 443–50; in fragrance materials, 462, 470, 471, 482; in cooking, 486–87, 489–91, 492–94, 528, 532; in wine barrels, 572; in beers, 577; in whiskies, 588. *See also* Maillard reactions in cooking
- pyrroline, 62, 117, 181, 215, 263, 277, 491–92, 493, 508. *See also* acetyl pyrroline
- qu, fermentation starter, 552, 579–80, 589
- quince, 305, 305
- rabbit tobacco, 204, 205
- radiation, volatile-creating: ultraviolet, 73, 109, 111, 380; infrared, 406, 492–93
- radicchio, 245, 245
- radishes, 271, 271
- rain, 340, 366–67, 374, 402
- raisins, 523, 523
- rancid smells and rancidity, 43, 59, 63, 65, 86, 120, 122, 279, 347, 506, 536–39, 562
- rancio smell in brandies, 587, 587
- raspberries, 311, 312
- raspberry ketone, 180, 180, 529, 579
- rau ram, herb, 263, 263
- recao, herb, 258
- red algae, 375, 376–78, 398–99
- Red Hots candies, 197
- red kidney beans, 278
- redwood trees, 136, 190, 192, 192
- Reeves, Hubert, 38
- refrigerators, 545
- Reichenbach, Carl, 416, 425–26
- repellents, animal, 62, 79, 82, 88: in plants, 136–37, 140, 142–43, 163, 178, 180, 244, 274, 298; artificial, 417, 501
- resins: tree, 143, 164, 173, 177, 180, 187, 190–96, 194–95, 200, 279, 473; creosote bush, 204–5, asafetida, 282, 283; pyrolyzed, 415, 417; storax and plastic, 428; in fragrances, 443–44, 445, 461–62, 462, 468, 471, 472
- resistant starch, 96, 97
- Rhizopus* mold, 344, 551, 556–57, 580
- rhubarb, 246, 247
- rhum agricole, 590, 590–91
- rice, 263, 268, 275, 276–77, 277, 519, 538
- rice wines, 579–81, 580–81. *See also* awamori; huangjiu; sake; shochu
- Riesling wines, 14, 420, 571, 571
- ripeness, 18, 139–40, 157, 296
- RNA, 19, 58, 60, 117
- Road to Wigan Pier*, *The* (Orwell), 123
- roasted foods and roasting, 10, 334, 489–91, 492–93, 495, 501, 503, 503–5, 518, 529–32, 576, 590. *See also* Maillard reactions in cooking; *names of specific foods*
- Robinson, Victor, 403, 424, 434
- rocket (arugula), 182, 183, 246, 246
- rocks, 30, 33, 38, 368–69, 407, 503
- Rollo, John, 92
- roots (plant), 267, 268–74: sassafras, 179, 197, 198; vegetable, 268–71, 516; pungent, from cabbage and garlic families, 271–72; aromatic, 263–74; tree symbioses with fungi, 343, 353, 355–56, 358; fragrance materials, 463–64, 464, 472. *See also names of specific roots*
- Roquefort cheese, 567
- rose family fruits, 303–7, 308–11
- rose flowers, 229, 230, 232, 232, 238–41, 240: fragrance extracts, 452, 456–57, 457, 458, 458, 479
- rose oxide, 167, 168, 328, 571
- rose water, 238, 456, 457
- rosemary, 248–49, 251, 251
- rosewood, 462, 462, 479
- rot and rotting: smells of, 55, 535: and primordial molecules, 10, 14; and sulfur volatiles, 10, 14, 58–59; and branched acids, 19, 59–60; and phenol rings, 20, 59–60; and protein breakdown, 58–62; and sulfur volatiles, 10, 14, 58–59; and nitrogen volatiles, 60–62; and animal bodies, 63–64; in flowers, 214–16; and fungi, 340, 353; algae, 377, 401; and fermentation, 535, 553, 562; household malodors, 545–46; and spoiled foods, 547. *See also* compost; excrement; rotted amaranth; rotten eggs; swamps and marshes
- rotted amaranth, 553, 594
- rotten eggs, 36, 502
- rotundone, 170, 286, 288, 529
- Roudnitska, Edmond, 480
- roux, 521, 522
- rubber, 171, 207, 428, 430, 433
- rue, 203, 204
- rums, 590–91
- Runge, Friedlieb, 426
- Ružička, Leopold, 474
- rye, 276, 276, 521, 522, 588, 588
- Saccharomyces* yeasts, 362–63, 364, 550, 570, 575, 577–79
- safflower oil, 494, 495
- saffron, 223, 223, 267, 284, 285, 464
- safranal, 171, 172, 223
- safrrole, 179, 180, 192, 198
- sage, 248, 251, 251
- Saigon cinnamon, 198
- Saint-Marcellin cheese, 550
- sake, rice wine, 581, 581
- salads, 242, 243–44
- salami, 549, 562, 563
- saliva: and breath, 105–6; and aroma release, 108, 531; and fermentation, 575. *See also* breath; mouth
- salmon, 348, 389, 391, 507, 508, 535
- salt: in oceans, 61, 371, 374; and ocean smells from phytoplankton and algae, 377–78, 398–400; and fish and shellfish smells, 386–87, 388, 395–97, 508–9; and cured foods, 539; and fermented foods, 553, 558, 561, 562
- salt, table: black, 37, 368; sea, 399
- salt-cured olives, 554
- salt-rising bread, 555, 556
- saltwater fish, 386–89, 388–89, 506–8, 508
- sambac jasmine, 233, 233
- sandalwood, 199, 443–44, 446, 462, 479
- sansho, 262, 262, 287, 287
- sanshools, 286
- santalene, 170
- santalols, 170, 199, 462
- Sartre, Jean-Paul, xix–xx, xxiii, 594
- sassafras, 179, 197, 198
- Satapatha Brahmana (Sanskrit text), 75–76
- satsuma citrus, 320, 322
- sauce-aroma baijiu, 589
- sauses: basil pesto, 255–56; soy, 325, 344, 549–50, 551, 557–58, 559, 591; fish, 549–50, 561–62, 562
- sauerkraut, 553, 554
- sausages, 538, 549, 551, 562, 563
- sautéing onions, 511–12. *See also* frying and fried foods
- Sauternes, 574, 574
- scallops, 395, 396, 509, 509
- scalp and hair smells, 113–14, 114
- Scent from the Garden of Paradise* (King), 467
- scent glands, animal: 78, 80, 82, 83, 88, 89, 120, 466. *See also* castoreum; musks
- scented candle, *tian op*, 493, 494
- Schieberle, Peter, 488
- Schiestl, Florian, 141, 592
- SCOBY (symbiotic culture of bacteria and yeasts), 585
- Scotch whisky, 401–2, 588
- sea lettuce, 391, 400, 401
- sea parsley, 400
- sea salt, 400, 400
- sea urchins, 396, 397
- seabirds, 72
- seafoods: fresh, 382–400; cooked, 506–9; cured, 541, 541. *See also* fish; fishy smells; seaweeds; shellfish
- seashore smells, 372–73, 378, 379–80: synthetic, 476
- seaweeds, 375–76, 379–81, 382–84, 397–400, 399–400, 401–2
- sebaceous glands and sebum, 75, 86, 109–11, 113, 116, 119
- sedanenolide, 257
- seed condiments, fermented, 557–60, 559. *See also names of specific condiments*

- seeds, 138, 139–40, 296: grains, 274–77; beans, 277–78; peanut and tree nuts, 278–81; spices, 281–88, 290, 291; oil sources, 452, 495, 497; cooked, 518–22, 528–31; fermented, 555–60, 575–81, 584–85. *See also names of specific seeds and seed products*
- self-enurination, 85
- semen, 62, 116, 117–18, 118, 181, 215
- sencha tea, 542, 543
- Sense and Sensibilia* (Aristotle), 210
- Serres, Michel, 3, 22, 23, 55–56
- sesame oil, 452, 495, 496
- sesquiterpenoids, common woody plant volatiles, 164, 169–71: in tree resins, 191, 196, 198; unusual, in sandalwood, 199; in agarwood, 200; in grapefruit, 324; in aromatic roots, 463–64. *See also names of specific molecules*
- Seville oranges, 322, 323
- sex and sexual smells, 62, 79, 85, 91, 116–19, 118, 212, 215
- Shakespeare, William, xii, 107, 146–47
- Shalimar (fragrance), 480
- Shanghai yeast balls, 579–80
- Shanxi vinegar, 584, 585
- sheep, 78, 84–86, 87, 124, 126, 500. *See also feta cheese; pecorino romano cheese*
- shellfish: 378, 381–82, 384, 386–87, 392–97; fragrance material, 471, cooked, 506, 507
- Shepherd, Gordon M., xxx
- sherry: wine, xiv, 573, 574; vinegar, 582, 583
- shiitake mushrooms, 343, 354–55, 355, 369
- shiso, herb, 251, 252
- shochu, spirit, 588, 589
- shower curtains and stalls, 429–30, 546
- shoyu furanone, 558
- shrimp, 396, 396–97, 508, 508; fermented pastes, 561, 563
- shrubs, 203–5, 204, 216
- Siam benzooin, 194, 195
- Sichuan pepper, 287, 287
- signaling smells: in animals, 78–84, 85–87; in insects, 88–90, 141, 163, 591–92; in humans, 109, 119–20; in plants, 136–41, 163, 591–92; in cheese mites, 569
- sillage, 596
- silver wattle flowers, 234, 235
- simmering, 492
- skatole, 61, 61–62: in excrement, 67, 70–71, 97, 97; in lamb meat, 86, 87; in insect smells, 88, 89; in flower scents, 215, 219–20; and tobacco smells, 447–48; in animal fragrance materials, 465; in cooked food smells, 493, 504
- skim milk, 499
- skin and skin microbiome, 108–13: scalp, 113–14; feet, 114–16; vagina, 116–17, 118; armpits, 119–22, 121–22, 122–24, 125–26, 127; and fragrances, 454, 465, 477–78. *See also pet smells*
- skunk cabbage, 215, 216
- skunks and skunky smells, 78, 81, 82–83, 83
- smell receptors, xx–xxi, xxix–xxx, 101, 103
- smelling salts, 11
- smelts, 382, 389
- smen, 564, 565
- smog, 434
- smoke, 404–5, 408–10, 411–15, 412, 413: toxic effects, 433–36, 446; and incense, 441–42, 443–46, 445; tobacco, 446–49; cannabis, 449; moxa, 449–50; smoked foods, 201, 415, 419, 493–94, 494; smoke taint in wines, 575
- smoker's breath, 448
- Smoky Mountains, 208
- smudging, 444
- snapdragon, 227, 228
- soaps and soapy smells, xxviii–xxix, 45, 258, 263, 270, 282, 424, 432, 546
- social smells, 119, 122–24, 450. *See also sex and sexual smells; signaling smells*
- sodium chloride, 10, 374, 377. *See also salt; salt, table*
- Sodom and Gomorrah* (Proust), xiii
- softwood trees, 414–15
- soils, 339–41, 345–47, 347–49, 366–67, 370
- solvents and solvent-like smells: primordial and starter-set molecules, 4, 13–14, 16–17, 44–45, 47–48, 51; turpentine, 417; petrochemicals in household materials, 420–24, 430–33, 432, 433–35, 437; intoxication from huffing, 434; in fragrance extractions, 454–56
- soma, 75–76
- sorghum, 524, 525
- sotolon, 172, 524: characteristic of fenugreek and maple syrup, 104, 113, 284, 525; in cooked celery, 257, 510–11; in mushrooms, 354, 356; in sweet cooked food bouquet, 490; in soy sauce, 558; in wines, 573, 580–81
- sour cherries, 306, 307
- sour cream, 547, 564, 564
- sour (Seville) orange, 320, 322, 323, 523
- sourdough breads, 520–21, 522, 549, 555, 556
- sourness, xx, 5, 10, 17, 59, 545, 545, 548
- soy cooking oil, 495, 538, 538
- soy infant formulas, 95
- soy pastes and sauces, fermented, xiv, 549–51, 557–60, 559
- soybeans, 277, 522, 522, 545, 560
- Spanish jasmine, 233, 233
- Spanish tarragon, 260, 260
- spearmint, 187, 249–50, 250, 252
- spices, 267–68, 271–74, 281–94: common volatiles, 178–80. *See also names of specific spices*
- spikenard, 463, 464
- spinach, 246–47, 514, 515
- spirit vinegar, 582, 583
- spoiled foods, 545, 547
- sponge cake, 528, 528
- spraints, 78
- springtail insects, 141
- spruce trees, 192, 192
- squash, 236–37, 237, 518: blossoms, 220
- squid, 395–96, 396, 468, 508–9, 509
- SSDS ("sudden sniffing death syndrome"), 434
- St. John (restaurant), xii, xiv, 593
- staleness, 536–39, 577: in grains and flours, 275; in seafood, 384–87; in skim milk, 499; in beer, 577
- Staphylococcus* bacteria, 115, 120
- star anise, 290, 290
- star-struck pine, 192–93, 473
- stars and stellar chemistry, 3–8, 9, 38
- starter-set carbon chains, 39–51
- steaming, 492
- Steinbeck, John, 372–73
- stem or asparagus lettuce, 514, 515
- Stevenson, Robert Louis, 533
- stews, 512–13, 513
- Stilton cheese, 567
- stinkbugs, 88, 89, 258
- stinkhorn mushroom, 352
- stinking goosefoot, 181, 203, 204, 261
- stinky bean, 278, 278
- stinky tofu, 553, 553, 556–57
- stock (flower), 228, 228
- stone fruits, 297, 303, 306–8, 307
- stones, 30, 33, 38, 368–69, 369, 407, 503
- straw mushroom, 354, 355
- strawberries, xxix, 153, 154, 157, 160, 298, 308–11, 310: preserves, 523
- strawberry furanone. *See furaneol*
- Streptococcus* bacteria, 112
- streptomycete bacteria, 344, 345, 348–49, 364, 366
- strong-aroma baijiu, 589
- strychnine, 137
- styrene, 195, 414, 420, 425, 428, 430, 435
- Su Shi, 419
- subtropical and tropical fruits, 318–35, 328, 330
- sufu, 556, 556–57
- sugars, 40, 150, 153: volatiles from tobacco, 448; in cooking, 486–87, 486–88, 489–91, 524–25, 528, 529, 530; in fermented foods and drinks, 552–91 *passim*
- sulfanes, 368, 369
- sulfides, methyl, common products of living metabolism, 59, 182–84; garlic and cabbage family specialists, 182–84; in ocean smells, 376–79; in sulfurous cooked food bouquet, 490.

- See also dimethyl sulfide (DMS); dimethyl disulfide and trisulfide sulfates, 183, 183, 184, 512
- sulfur, element in volatile molecules, and sulfurous smells: primordial and geologic, 10, 14, 21, 23–24, 26–29, 36–37; and origins of life, 30–31; and anaerobic metabolism, signs of death and decay, 34–35, 57–58; and “eggy” smells, 36, 501, 541; and mineral smells, 37, 367–69, 572; from protein breakdown, 58–59; and animal smells, 67–68, 74, 81, 83; in human excrement and flatulence, 95, 97–99, 100–101, 102–3; in breath, 105–8; in body odors, 116, 121–22; in plants, 150, 153, 181–84; in flowers, 215–16; in cabbage family, 246, 271–72, 285, 287, 515–16; in garlic family, 263, 271–72, 511–14; in fruits, 300–302, 333–34; in compost, 347; in mushrooms, 352–57; in truffles, 358–62; from struck stones, 367–69; from wetlands, 370; in oceans and seafoods, 374, 377–79, 395–96, 398–401, 509; in automobile tires, 429; in cooked foods, 489–90, 503–4, 511–14, 516, 518–19, 529, 539; in household malodors, 545, 547; in fermented foods, 548, 554, 556, 558, 561–62, 566–69; in fermented beverages, 572–74, 576–77, 581–82, 589–90.
- See also names of specific sulfur molecules
- sulfur dioxide, 10, 24–27, 30, 34, 523, 572
- Sumatra benzoin, 194, 195
- summer savory, 250, 251
- sunchoke, 269, 269
- sunlight, effects on volatiles, 73, 86, 109, 111, 112, 113, 164, 367, 380
- supercritical fluid extraction, 456
- surrströmning, 533–34, 562, 563
- swallowtail (butterfly and caterpillar), 77, 88, 89
- swamps and marshes, 370–71
- sweat, 94, 109–10; in pets, 73–74; and skin odors, 111, 112; and foot odors, 114–15; and armpit odors, 119–22, 121–22, 122–24, 127; reduction, 122–23; fenugreek smells in, 284; and fruit volatiles, 301; and meat flavors, 513–14. See also body odors; sweaty-smelling volatiles
- sweaty-smelling volatiles: primordial and starter-set, 19–20, 42–43, 48, 51; from protein breakdown, 58–60, 60; in lamb and wool, 86–87; in breath, 105; in plants, 167, 170, 183, 204, 221, 228, 274, 283, 313, 328–29; in tobacco, 448–49; and cooked meats and stews, 504–5, 513–14; and cooked vegetables, 510, 517, 518; and breads, 521–22, 555–56; and malt, 525; and chocolate, 530–31; and hams, 539; in household malodors and spoiled foods, 545–47; in fermented foods, 548–50, 557; in cheeses, 127, 565–69; in wines, 572, 575, 581; in beers, 576–77; in vinegars, 582; in distilled spirits, 588–89. See also body odors; sweat
- sweet (plant names): alyssum, 225, 226; cherry, 306, 307; corn, 517, 518; everlasting, 204, 205; grass, 206, 445; gums, 195, 195; oranges, 320, 322, 323; pea, 229, 230; potatoes, 269, 269, 516, 517; vernal grass, 206, 207; William, 228, 228; woodruff, 178, 206, 207
- sweet (taste), xx, 146; applied to plant smells, 146–47, 158–59, 172–73, 179; pyrolysis and solvent smells, 410–15, 420–21; cooked bouquet, 490–91
- sweetbrier, 238, 241
- sweetened condensed milk, 500
- Swiss cheese, 41, 116, 550, 567
- symbiotic relationships: and body odor, 125; and flowers and fruits, 138–40, 212–13, 296–97, 296; and soil fungi, 343–44, 353, 355–57, 356–57; and truffles, 358–59; and yeasts and fermented foods, 364, 591–92; and kombucha, 585
- synthetic volatiles and smells, 148, 268, 292, 404, 432; in fragrances, 456, 457, 474–77, 478–80, 594–95
- Syrah grape and wine, 170, 571
- syringol, 412, 413, 415
- syrups: caramel, 4–5, 486–87, 486–88; maple, 173, 284, 524–25; malt, 525; sorghum, 524–25
- TAARs (trace amine-associated receptors), 63, 79
- table grapes, 175, 313
- tagetone, 236, 260
- Tahitian vanilla, 292–93, 293
- Taleggio cheese, 116
- Tang dynasty, China, 114, 123
- tangelo, 323
- tangerines, 322
- Tangerman, Albert, 100–101
- tangor citrus, 323
- tar and tarry smells, 403, 405, 413–19, 414, 417, 422–27: primordial, 20; from protein breakdown, 58–60, 60; toxic effects of, 433–36; in fragrances, 462
- tarragon, 259, 260
- Taste of Wine, *The* (Peynaud), 107–8
- taste, smell’s partner chemical sense, xii, xx, 7, 146, 184, 392–93, 398; and cooking, 485–86; and fermentation, 535; and curing, 540
- taurine, 386, 392, 398
- TDN (trimethyl-dihydro-naphthalene), 420, 571
- tea, xxv–xxvi, 161–62, 169, 233, 325, 459, 493, 494, 542–44, 544
- tea-smoking, 493, 494
- Techamuanvivi, Pim, 90
- tempeh, 556, 557
- Temple oranges, 323
- Tepe Gawra, 451
- tequila, 590, 590
- terebinth tree, 163, 279, 417
- terpenes, xvi, 163, 230, 427, 517. See also terpenoids
- terpenoids, widespread plant volatiles, 163; monoterpenoids, 164–69; sesquiterpenoids, 169–70; terpenoid relatives, 171–72; in liverworts, 188; in tree resins and woods, 191–200, 415; in forest emissions, 208; in flowers, 217–19; in herbs, 249–54, 257, 261–65; in spices, 273, 281–90; in citrus fruits, 319–21, 324, 326; relatives in soil smells, 348–49; in tobacco, cannabis, and moxa, 447–49; in cooked foods, 510, 516, 529; in wines, 570. See also isoprene; monoterpenoids; sesquiterpenoids; terpenes; names of specific terpenoids
- terroir, 358, 359
- Tête de Moine cheese, 116
- Thai: aromatic pastes, 270, 273, 562–63; basil, 255, 255; rice, 277; sauces, 90, 561, 562; scented candle, 494
- Theophrastus, 450
- thiocyanates, 182, 184. See also isothiocyanates
- thiols, sulfur volatiles, 183: primordial, 14, 36; and protein breakdown, 59; and animal smells, 65, 67, 71, 81, 83, 88; in human body smells, 96–97; in plants, 183, 300–301, 317, 333–34; in mushrooms, 353, 356; in wines, 368; struck stones, 369; created in cooking, 489–90, 493, 503, 507, 509, 511, 529, 530; in fermented foods, 548, 558, 566; wines, 368, 571–73; in beers, 576–77. See also methanethiol; names of specific thiol molecules
- Thomas, Dylan, 213
- Thomas, Richard, 339–40, 366, 367
- Thoreau, Henry David, 148–49, 186, 215, 297
- thujone, 165, 259
- thyme, 248, 250, 250, 252–54, 254
- thymol, 165, 166: medicinal associations, 106, 142–45; pungent chemical weapon, 145–46; plant terpenoid, 165–66; in thyme and oregano, 250–54; in other herbs and spices, 255, 261, 283; in citrus peels, 321, 325
- tian op, scented candle, 493, 494
- Tian Shan mountains, 302–3, 308
- tianmianjiang (fermented wheat paste), 560, 560
- tidal breathing, 209
- tilapia, 387, 389, 390, 390, 391
- tinctures, 454, 456
- titan arum (corpse flower), 214, 215, 216

- TMA and TMAO (trimethylamine and its oxide), 61, **386**: in animal death, 63–64; in pets, 74; in urine 103; in vaginal infections 117; in stinking goosefoot, 203; in fish and shellfish, 386–88, 393, 395–96; in cured duck eggs, 541; in fish sauces, 561
- toasting and toasted foods, 280, 285, 398, 489, 491, 492–93, 495, 520: oak barrels, 572–73, 588
- tobacco, 446–50, 473
- “toe cheese,” 114, 127. *See also* feet
- tofu, 522, 553, 556–57
- Tokaji Aszú, 574, 574
- toluene, 345–46, 414, 420, 425, 431, 435–36, 494
- tomatillos, 317, 318
- tomatoes, 261, 262, 317–18, 318, 509–10, 547
- tomme de Savoie cironée cheese, 569, 569
- tonka bean, 178, 291, 292
- tortillas, 74–75, 313–14, 519–20
- trace amine-associated receptors (TAARs), 63, 79
- traditional medicines, 199, 259, 261, 449, 470
- Travels through North and South Carolina* (Bartram), 295
- Travels with Charley* (Steinbeck), 372
- tree nuts, 278–81, 280–81
- tree peonies, 224, 224
- trees, 132: evolution, 135–36, 138, 341, 406; conifers, 163, 190–93; resinous hardwoods, 193–96; aromatic hardwoods, 196–200; mild hardwoods, 200–201; forest volatiles, 201–9; and soil fungi, 343, 353, 354, 355–57; and truffle symbiosis, 358–59, 361–62; and beaver castoreum, 470; sap syrups from, 525; and paper, 601. *See also* fire; wood; *names of specific trees and tree products*
- Trésor (fragrance), 480, 480
- tribromophenol, 381
- trimethoxybenzene, 232, 239
- trimethyl glycine (TMG), 386
- trimethylamine (TMA) and its oxide (TMAO), 61, **386**: in animal death, 63–64; in pets, 74; in urine 103; in vaginal infections 117; in stinking goosefoot, 203; in fish and shellfish, 386–88, 393, 395–96; in cured duck eggs, 541; in fish sauces, 561
- trimethyl-dihydro-naphthalene (TDN), 420, 571
- triterpenoids, 464, 468
- Trockenbeerenauslese wines, 574, 574
- trout, 387, 389, 390, 391, 507, 508
- truffles, 344, 358–62, 360–61
- tryptophan, 61–62, 520
- tuberose, 236, 237, 458, 459
- tubers, 268–69, 516, 534
- tulips, 230, 231–32
- tuna, 388–89, 389, 507, 508, 561, 563
- turkey, 505, 505
- turmeric, 268, 273, 273
- turnips, 271, 271
- turpentine, 143, 163–64, 191, 262, 279, 417, 417–18, 426, 431–32
- ultra-high-temperature (UHT) milks, 500, 500
- ultraviolet (UV) radiation, 9, 34: and hair and skin smells, 73, 75, 86, 109, 111, 113; and plant benzenoids and isoprene, 174, 208; and seacoast volatiles, 380, 401; and stale flavors, 536, 538, 538, 579
- Ulva* seaweed, 400, 401
- umami, xx
- umbellulone, 165, 166, 167, 198
- undersea vents, 28–29, 37, 62
- Unilever, 93
- unrefined: olive oil, 496; palm oil, 497; salts, 400; sugars, 172, 524–25
- unsaturated carbon chains, 50: prone to breakage into small volatiles, 502, 537
- urine, 67, 78–81, 101–2, 101–4, 104: nitrogenous ammonia and amines, 11, 60–62, 103; cat marking signal, 80, 81; diagnostic smells, 92, 103; and asparagus, 102
- UV. *See* ultraviolet (UV) radiation
- valerian, 247, 273–74, 274
- van Helmont, Jan Baptiste, 421
- vanilla, 267, 292–93, 293, 332, 333, 412–13, 459, 531
- vanillin, 179, 180: in woods, 201; in whole grains, 276; in vanilla, 292–93, 332; in woodsmoke, 412–13; and early organic chemistry, 427, 475; in fragrances, 479; in coffee, 529; in chocolate, 531; in barrel-aged wines and spirits, 573, 586
- Vedic medicine, 92
- vegetables: leafy greens, 244–47; roots and tubers, 268–72; bulbs, 272; nightshade family fruits, 317–18; seaweeds, 397–400; cooked, 509–18; fermented, 548, 552–54. *See also names of specific vegetables*
- vegetables, fermented, 552–54. *See also* pickled foods; *names of fermented vegetables*
- vermouth, 259
- vetiver, 463, 464
- Vietnamese coriander, 263, 263
- vinegar, 582–85, 583–84: acetic smells, 17, 21, 40–41, 46; in excrement, 95–98; and *Brettanomyces* yeasts, 365; in woodsmoke, 410; in plastics, 429; in sourdough bread, 520; chocolate, 532; in fermented foods, 548, 549, 550
- vinegaroons, 89
- vinous bouquet in wines, 570
- vinyl carbon group, 412
- vinyl plastics, 428–29, 429, 431
- vinylguaiacol, 276, 365, 412, 413, 577
- violet: flower, 225, 225, 464; leaf, 459–60, 460. *See also* ionones
- Virginia strawberries, 309, 310
- vodka, 586, 587
- volatile molecules, xi–xii, xvi, xix–xxix: identification of, xxvi–xxvii, 424–27; smallest, 10–11; carbon chains, 11–12, primordial, 21; byproducts of living metabolism, 30–35, 39–40; byproducts of protein metabolism, 58–62; animal signals, 77–90; human signals, 119–22, 124; plant defenses and signals, 136–40; byproducts of combustion and pyrolysis, 409–10, 411–15, 419–21; capture in perfumery, 450–57; synthetic, 453–77; products of cooking, 486–91. *See also names of specific molecules and source materials*
- volcanoes, 10, 23, 24, 25–27, 30, 34
- vomit, 41–42
- wakame, 398, 399
- Wallace, Alfred Russel, 295, 296–97, 333–34
- walnuts, 280, 280
- warmed-over flavor (WOF), 538, 538
- wasabi, 182, 271–72, 272
- washed-rind cheeses, 115, 115–16, 566, 567
- washing machines, 546
- water, 8, 10: and volatility of carbon chains, 12, 74, 87, 585–86; and evolution of life, 25, 31–32; as environment for living things, 373–76; disadvantages in perfumery, 455. *See also* wet-up
- water buffalo milk and mozzarella, 565, 566
- water lilies, 211, 218, 222–23, 223
- water mint, 252, 253
- watercress, 246, 246
- watermelons, 316, 316
- wattle flowers, 234
- Weatherall, Ben, xiv
- Weissbier, 578, 579
- western cedar tree, 191–92, 192
- wet-dog smell, 74, 75, 463
- wet-up: of soil and stone, 366–67, **367**; of dry foods in mouth, 531
- wetlands, 370, 370–71
- wheat, 275–76, 276, 520–21, 521–22
- wheat paste, fermented, 560
- whiskey or oak lactone, 201
- whiskeys and whiskies, xxvi–xxvii, xxxi, 401–2, 588, 588
- white chocolate, 531
- white (Madonna) lily, 223, 223, 226, 226
- White Linen (fragrance), 480, 480
- white pepper, 286, 287
- white truffles, 360–61, 361–62
- white water lily, 223, 223
- whole grains and their breads, 98, 276, 276, 415, 518, 519, 520, 521

- wild "Alpine" strawberries, 298, 308–9, 310, 311, 331
 "Wild Apples" (Thoreau), 148
 wild rices, 519, 519
 Wilde, Peter, 452–53
 will-o'-the-wisp, 371
 Willis, Thomas, 92
 Wilson, E. O., 213
 wine cellars, 352
 wine lactone, 299, 300, 325
 wine vinegars, 582–83, 583
 wines, 533, 569–75: primordial and starter-set molecules, 10, 16–18, 43, 48–49; and "mineral" smells, 23, 368–69; and barrels, 179, 201, 292; animal/exotic sulfur volatiles, 183, 301; and yeasts, 363–65; and distillation, 453–54; and fishy aftertastes, 507. *See also* rice wines; sake, rice wine; vinegar; *names of specific wine grapes and wines*
 winter savory, 250, 251
 winter squash, 517
 wintergreen, 143, 174–75, 217, 219, 264, 264, 458–59
 wisteria, 232, 232
 wok hei ("breath of the wok"), 494
 wood, 135–36, 137, 151, 173, 190–201: woody terpenoids, 164–66, 170–71; and barrel-aged alcohols, 179, 572, 572–73, 587; decomposed by fungi, 343, 353–55; smoke, 408–18; wood tar and pitch, 415–18; fragrance materials, 444–46, 446, 462, 479, 481–82. *See also* lignin; pyrolysis; trees; turpentine
 wool, 84–87, 432
World I Live In, The (Keller), 185
 wormwood, 245, 259, 260, 449–50
 Wrangham, Richard, 56, 407
 xenobiotic molecules and metabolism, 94, 104, 107, 120, 435–36
 xylene, 345–46, 414, 420, 425, 435: musk xylene, 474
 yarrow, 203, 204
 yeast extract, 503, 504
 yeasts, microscopic fungi, 57, 341–44, 362–65: name, 362; on human body, 110, 113–14, 116–17; and vanilla curing, 293; in soils, 341–44; and alcohol, 351–52, 362–63; and breads, 363, 520–21; and diverse fruity-flowerly volatiles, 363–65; and symbiosis with insects, 364, 591–92; and "mineral" aromas in wine, 369; and chocolate, 532; and household malodors, 545–46; and fermented foods, 550–51, 554, 555, 557–58, 562, 563, 566; and alcoholic wines, beers, and vinegars, 569–81, 582–85; yeast balls, 579–80; and kombucha, 585; and distilled spirits, 585–91; and evolution of flower and fruit scents, 591–92. *See also* *Saccharomyces* yeasts; *Brettanomyces* yeasts; *Zygosaccharomyces* yeasts
 yellow wine, China, 580–81, 584
 yellowfoot mushrooms, 356, 357
 Yellowstone National Park, 27–28, 31
 yerba buena, 251–52, 252
 ylang-ylang, 458, 458–59, 479
 yogurt, 548–49, 564, 564
 Young, James, 422
 Yu Bo (chef), 589
 yuzu, 325, 325
 zedoary, 273, 273
 Zhenjiang vinegar, 584, 584–85
 zhi xiang baijiu, 589, 590
 zingiberene, 170, 171, 273, 287
 zingiberenol, 170
 zizaenones, 463
 zooplankton, 376
 zucchini, 236–37, 237
Zygosaccharomyces yeasts, 550