

Biomonitoring California Designated Chemicals February 2011

The designated chemicals for Biomonitoring California^a are provided in this list. Designated chemicals consist of those substances that are included in the Centers for Disease Control and Prevention's (CDC's) biomonitoring studies^b and additional chemicals that are recommended by the Scientific Guidance Panel (SGP) for Biomonitoring California. Designated chemicals are the pool of chemicals from which the SGP can recommend priority chemicals for biomonitoring.

Targets for measurement in biomonitoring studies could include the parent chemical, metabolites and other chemical products formed in the body or the environment (e.g., hemoglobin adduct; environmental degradation product). The approach for biomonitoring a chemical may change as methods development proceeds. The parent chemical is provided in the list below, with other targets for biomonitoring shown indented underneath for some parent chemicals. Biomonitoring California determines the chemicals that are actually biomonitored and the appropriate targets for measurement.

Acrylamide

Acrylamide hemoglobin adducts
Glycidamide hemoglobin adducts

Antimicrobials used in Food Production¹

Brominated and Chlorinated Organic Compounds used as Flame Retardants¹

2,2-Bis(bromomethyl)-1,3-propanediol
2,2-Bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate]
Bis(2-ethyl-1-hexyl)tetrabromophthalate (TBPH)
Bis(hexachlorocyclopentadieno)cyclooctane (Dechlorane Plus)
1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane
2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
Chlorendic acid
Decabromodiphenylethane (DBDPE)
Hexabromobenzene
2,2',4,4',5,5'-Hexabromobiphenyl (BB 153)
Hexabromocyclododecane (HBCD)
Hexachlorocyclopentadienyl-dibromocyclooctane
N,N'-Ethylenebis(tetrabromophthalimide)
Pentabromoethylbenzene
Pentabromotoluene
Short-chain chlorinated paraffins
Tetrabromobisphenol A (TBBPA)

Tetrabromobisphenol A bis(2,3-dibromopropyl) ether
Tetrabromobisphenol A bis(2-hydroxyethyl) ether
Tetrabromophthalic anhydride
Tetrakis(2-chloroethyl)dichloroisopentyl diphosphate
2,4,6-Tribromophenol
Tris(2-chloroethyl)phosphate (TCEP)
Tris(1-chloro-2-propyl)phosphate (TCPP)
Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)
Tris(2,3-dichloro-1-propyl)phosphate

Polybrominated diphenyl ethers (PBDEs)

2,2',4-Tribromodiphenyl ether (BDE 17)
2,4,4'-Tribromodiphenyl ether (BDE 28)
2,2',4,4'-Tetrabromodiphenyl ether (BDE 47)
2,3',4,4'-Tetrabromodiphenyl ether (BDE 66)
2,2',3,4,4'-Pentabromodiphenyl ether (BDE 85)
2,2',4,4',5-Pentabromodiphenyl ether (BDE 99)
2,2',4,4',6-Pentabromodiphenyl ether (BDE 100)
2,2',4,4',5,5'-Hexabromodiphenyl ether (BDE 153)
2,2',4,4',5,6'-Hexabromodiphenyl ether (BDE 154)
2,2',3,4,4',5',6-Heptabromodiphenyl ether (BDE 183)
2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE 209)

Cyclosiloxanes¹

Decamethylcyclopentasiloxane (D5)
Dodecamethylcyclohexasiloxane (D6)
Octamethylcyclotetrasiloxane (D4)

Diesel Exhaust²

- California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California), codified at Health and Safety Code section 105440 et seq.
- Known collectively as the National Reports on Human Exposure to Environmental Chemicals program.

**Disinfection By-Products
(Trihalomethanes)³**

Bromodichloromethane
Dibromochloromethane
Tribromomethane (Bromoform)
Trichloromethane (Chloroform)

Environmental Phenols³

Benzophenone-3
Bisphenol A
4-*tert*-Octylphenol
Triclocarban⁴
Triclosan

Parabens³

Butylparaben⁵
Ethylparaben
Methylparaben
n-Propylparaben

Metals³

Antimony
Arsenic
 Arsenic (V) acid
 Arsenobetaine
 Arsenocholine
 Arsenous (III) acid
 Dimethylarsinic acid
 Monomethylarsonic acid
 Trimethylarsine oxide
Barium
Beryllium
Cadmium
Cesium
Cobalt
Lead
Manganese
Mercury
Molybdenum
Platinum
Thallium
Tungsten
Uranium

Perchlorate

Perfluorochemicals³

2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid
2-(N-Methyl-perfluorooctane sulfonamido) acetic acid
Perfluorobutane sulfonic acid

Perfluorodecanoic acid
Perfluorododecanoic acid
Perfluoroheptanoic acid
Perfluorohexane sulfonic acid
Perfluorononanoic acid
Perfluorooctane sulfonamide
Perfluorooctane sulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluoroundecanoic acid

Pesticides^{3, 6}

Carbamate Insecticides³

Benfuracarb
 Carbofuranphenol
Carbaryl
 1-Hydroxynaphthalene⁷
 2-Hydroxynaphthalene⁷
Carbofuran
 Carbofuranphenol
Carbosulfan
 Carbofuranphenol
Furathiocarb
 Carbofuranphenol
Propoxur
 2-Isopropoxyphenol

Fungicides³

Captafol
 Tetrahydrophthalimide
Captan
 Phthalimide
 Tetrahydrophthalimide
Chlorothalonil
Dichloran
Folpet
 Phthalimide
Iprodione
Mancozeb
 Ethylene thiourea
Maneb
 Ethylene thiourea
Metalaxyl
Metiram
 Ethylene thiourea
Nabam
 Ethylene thiourea
Pentachlorophenol
o-Phenylphenol
Propineb
 Propylene thiourea
Thiram
 Ethylene thiourea

Ziram
Ethylene thiourea

Herbicides - Substituted Ureas³

Bensulfuron-methyl
Chlorimuron-ethyl
Chlorsulfuron
Diuron
Ethametsulfuron-methyl
Foramsulfuron
Halosulfuron
Iodosulfuron
Linuron
Metsulfuron-methyl
Nicosulfuron
Primisulfuron-methyl
Prosulfuron
Rimsulfuron
Sulfometuron-methyl
Sulfosulfuron
Thifensulfuron-methyl
Triasulfuron
Triflusulfuron-methyl
Non-specific metabolites
 Dimethoxy pyrimidine
 Dimethyl pyrimidine
 Methyl methoxytriazine

Organochlorine Pesticides³

Aldrin
 Dieldrin
Chlordane
 trans-Nonachlor
 Oxychlordane
Dichlorodiphenyltrichloroethane (DDT) (including
 p,p'-DDT and *o,p'*-DDT)
 p,p'-Dichlorodipenyldichloroethene (DDE)
Dieldrin
Endosulfan
 Endosulfan-ether
 Endosulfan-lactone
 Endosulfan-sulfate
Endrin
Heptachlor
 Heptachlor epoxide
Hexachlorobenzene
 Pentachlorophenol
 2,4,5-Trichlorophenol
 2,4,6-Trichlorophenol
Hexachlorocyclohexanes (HCH) (including beta-
 HCH and gamma-HCH [lindane])
 Pentachlorophenol
 2,4,5-Trichlorophenol
 2,4,6-Trichlorophenol

Methoxychlor
 Dihydroxy methoxychlor
 Monohydroxy methoxychlor
Mirex
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Organophosphate Insecticides³

Acephate
Azinphos methyl
 Dimethyldithiophosphate
 Dimethylphosphate
 Dimethylthiophosphate
Chlorethoxyphos
 Diethylphosphate
 Diethylthiophosphate
Chlorpyrifos
 Diethylphosphate
 Diethylthiophosphate
 3,5,6-Trichloro-2-pyridinol
Chlorpyrifos methyl
 Dimethylphosphate
 Dimethylthiophosphate
 3,5,6-Trichloro-2-pyridinol
Coumaphos
 3-Chloro-7-hydroxy-4-methyl-2H-chromen-2-
 one/ol
 Diethylphosphate
 Diethylthiophosphate
Diazinon
 Diethylphosphate
 Diethylthiophosphate
 2-Isopropyl-4-methyl-6-hydroxypyrimidine
Dichlorvos (DDVP)
 Dimethylphosphate
Dicrotophos
 Dimethylphosphate
Dimethoate
 Dimethyldithiophosphate
 Dimethylphosphate
 Dimethylthiophosphate
Disulfoton
 Diethyldithiophosphate
 Diethylphosphate
 Diethylthiophosphate
Ethion
 Diethyldithiophosphate
 Diethylphosphate
 Diethylthiophosphate
Fenitrothion
 Dimethylphosphate
 Dimethylthiophosphate
Fenthion
 Dimethylphosphate
 Dimethylthiophosphate
Isazophos-methyl

5-Chloro-1,2-dihydro-1-isopropyl-[3H]-1,2,4-triazol-3-one
Dimethylphosphate
Dimethylthiophosphate
Malathion
Dimethyldithiophosphate
Dimethylphosphate
Dimethylthiophosphate
Malathion dicarboxylic acid
Methamidophos
Methidathion
Dimethyldithiophosphate
Dimethylphosphate
Dimethylthiophosphate
Methyl parathion
Dimethylphosphate
Dimethylthiophosphate
p-Nitrophenol
Naled
Dimethylphosphate
Oxydemeton-methyl
Dimethylphosphate
Dimethylthiophosphate
Parathion (Ethyl parathion)
Diethylphosphate
Diethylthiophosphate
p-Nitrophenol
Phorate
Diethyldithiophosphate
Diethylphosphate
Diethylthiophosphate
Phosmet (Imidan)
Dimethyldithiophosphate
Dimethylphosphate
Dimethylthiophosphate
Pirimiphos-methyl
2-(Diethylamino)-6-methylpyrimidin-4-ol/one
Dimethylphosphate
Dimethylthiophosphate
Sulfotepp
Diethylphosphate
Diethylthiophosphate
Temephos
Dimethylphosphate
Dimethylthiophosphate
Terbufos
Diethyldithiophosphate
Diethylphosphate
Diethylthiophosphate
Tetrachlorvinphos
Dimethylphosphate

Pyrethroid Pesticides¹

Allethrin
cis/trans-Dimethylvinylcyclopropane carboxylic diacid

Bifenthrin
Cyfluthrin
cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
4-Fluoro-3-phenoxybenzoic acid
Cyhalothrin (including *lambda*- and *gamma*-)
3-Phenoxybenzoic acid
Cypermethrin (including *cis*- and *trans*-)
cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid
Cyphenothrin
Deltamethrin
cis-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid
Esbiothrin
Esfenvalerate
Etofenprox
Fenpropathrin
3-Phenoxybenzoic acid
Fenvalerate
Imiprothrin
Metofluthrin
Permethrin (including *cis*- and *trans*-)
cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid
Phenothrin (sumithrin)
Prallethrin
Pyrethrin 1
cis/trans-Dimethylvinylcyclopropane carboxylic diacid
Resmethrin
cis/trans-Dimethylvinylcyclopropane carboxylic diacid
Tetramethrin
Tralomethrin
3-Phenoxybenzoic acid

Other Herbicides

Acetochlor
Acetochlor mercapturate
Alachlor
Alachlor mercapturate

Atrazine

Atrazine mercapturate
Diaminochlorotriazine
Desethylatrazine
Desisopropylatrazine
Hydroxyatrazine

Dacthal

2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters

2,4-Dichlorophenoxyacetic acid
2,4-Dichlorophenol

Metolachlor

Metolachlor mercapturate

Pendimethalin

2,4,5-Trichlorophenoxyacetic acid (2,4,5-T), salts and esters

2,4,5-Trichlorophenoxyacetic acid

Trifluralin

Other Pesticides

1,4-Dichlorobenzene (*p*-Dichlorobenzene)

2,5 Dichlorophenol

N,N-Diethyl-3-methylbenzamide (DEET)

Fipronil

Octhilinone

Phytoestrogens³

Daidzein
O-Desmethylangolensin
Enterodiol
Enterolactone
Equol
Genistein

**Polychlorinated Biphenyls (PCBs),
Dioxin-Like³**

Coplanar PCBs³

3,4,4',5-Tetrachlorobiphenyl (PCB 81)
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)

Mono-ortho-Substituted PCBs³

2,3,3',4,4'-Pentachlorobiphenyl (PCB 105)
2,3',4,4',5-Pentachlorobiphenyl (PCB 118)
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)

Phthalates³

Benzylbutyl phthalate (BzBP)

Mono-benzyl phthalate
Mono-*n*-butyl phthalate

Dibutyl phthalate (DBP)⁸

Mono-*n*-butyl phthalate
Mono-isobutyl phthalate

Dicyclohexyl phthalate (DCHP)

Mono-cyclohexyl phthalate

Diethyl phthalate (DEP)

Mono-ethyl phthalate

Di-2-ethylhexyl phthalate (DEHP)

Mono-(2-ethyl-5-carboxypentyl) phthalate
Mono-2-ethylhexyl phthalate
Mono-(2-ethyl-5-hydroxyhexyl) phthalate
Mono-(2-ethyl-5-oxohexyl) phthalate

Di-isodecyl phthalate (DiDP)

Mono-(carboxynonyl) phthalate

Di-isononyl phthalate (DiNP)

Mono-(carboxyisooctyl) phthalate
Mono-(hydroxyisononyl) phthalate
Mono-isononyl phthalate
Mono-(oxoisononyl) phthalate

Dimethyl phthalate (DMP)

Mono-methyl phthalate

Di-*n*-octyl phthalate (DOP)

Mono-(3-carboxypropyl) phthalate
Mono-*n*-octyl phthalate

**Polychlorinated Biphenyls (PCBs),
Non-Dioxin-Like³**

2,2',5-Trichlorobiphenyl (PCB 18)
2,4,4'-Trichlorobiphenyl (PCB 28)
2,2',3,5'-Tetrachlorobiphenyl (PCB 44)
2,2',4,5'-Tetrachlorobiphenyl (PCB 49)
2,2',5,5'-Tetrachlorobiphenyl (PCB 52)
2,3',4,4'-Tetrachlorobiphenyl (PCB 66)
2,4,4',5-Tetrachlorobiphenyl (PCB 74)
2,2',3,4,5'-Pentachlorobiphenyl (PCB 87)
2,2',4,4',5-Pentachlorobiphenyl (PCB 99)
2,2',4,5,5'-Pentachlorobiphenyl (PCB 101)
2,3,3',4',6-Pentachlorobiphenyl (PCB 110)
2,2',3,3',4,4'-Hexachlorobiphenyl (PCB 128)
2,2',3,4,4',5' and 2,3,3',4,4',6-Hexachlorobiphenyl (PCB 138 & 158)
2,2',3,4,5,5'-Hexachlorobiphenyl (PCB 146)
2,2',3,4,5',6-Hexachlorobiphenyl (PCB 149)
2,2',3,5,5',6-Hexachlorobiphenyl (PCB 151)
2,2',4,4',5,5'-Hexachlorobiphenyl (PCB 153)
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)
2,2',3,3',4,5,5'-Heptachlorobiphenyl (PCB 172)
2,2',3,3',4,5',6'-Heptachlorobiphenyl (PCB 177)
2,2',3,3',5,5',6-Heptachlorobiphenyl (PCB 178)
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)
2,2',3,4,4',5',6-Heptachlorobiphenyl (PCB 183)
2,2',3,4',5,5',6-Heptachlorobiphenyl (PCB 187)
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (PCB 194)

2,2',3,3',4,4',5,6-Octachlorobiphenyl (PCB 195)
2,2',3,3',4,4',5,6' and 2,2',3,4,4',5,5',6-Octa-
chlorobiphenyl (PCB 196 & 203)
2,2',3,3',4,5,5',6-Octachlorobiphenyl (PCB 199)
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (PCB
209)

Polychlorinated Dibenzo-*p*-dioxins³

1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)

Polychlorinated Dibenzofurans³

1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,4,6,7,8,9-Octachlorodibenzofuran
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
2,3,7,8-Tetrachlorodibenzofuran

Polycyclic Aromatic Hydrocarbons (PAHs)³

Benz[a]anthracene
1-Hydroxybenz[a]anthracene
3-Hydroxybenz[a]anthracene
9-Hydroxybenz[a]anthracene
Benzo[a]pyrene
3-Hydroxybenzo[a]pyrene
Benzo[c]phenanthrene
1-Hydroxybenzo[c]phenanthrene
2-Hydroxybenzo[c]phenanthrene
3-Hydroxybenzo[c]phenanthrene
Chrysene
1-Hydroxychrysene
2-Hydroxychrysene
3-Hydroxychrysene
4-Hydroxychrysene
6-Hydroxychrysene
Fluoranthene
3-Hydroxyfluoranthene
Fluorene
2-Hydroxyfluorene
3-Hydroxyfluorene
9-Hydroxyfluorene

Naphthalene
1-Hydroxynaphthalene
2-Hydroxynaphthalene
Phenanthrene
1-Hydroxyphenanthrene
2-Hydroxyphenanthrene
3-Hydroxyphenanthrene
4-Hydroxyphenanthrene
9-Hydroxyphenanthrene
Pyrene
1-Hydroxypyrene

Synthetic Hormones used in Food Production¹

Melengestrol acetate
Trenbolone acetate
Zeranol

Tobacco Smoke

Nicotine
Cotinine

Volatile Organic Compounds³

Benzene
Carbon tetrachloride
Chlorobenzene
Dibromomethane
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dichlorobenzene (*o*-Dichlorobenzene)
1,3-Dichlorobenzene (*m*-Dichlorobenzene)
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
Dichloromethane (Methylene chloride)
1,2-Dichloropropane
2,5-Dimethylfuran
Ethylbenzene
Hexachloroethane
Methyl-*t*-butyl ether (MTBE)
Nitrobenzene
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethylene (Perchloroethylene)
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Toluene
m-Xylene
o-Xylene
p-Xylene

Notes

¹ All members of the chemical class are designated chemicals, including, but not limited to, the chemicals shown.

² Diesel exhaust is a complex mixture that contains many components, one or more of which may be useful as an indicator for biomonitoring.

³ All members of the chemical class are not designated chemicals; only the specific chemicals listed are designated chemicals.

⁴ Triclocarban is not a phenol but can be analytically measured with environmental phenols. When it is released into the environment, it is commonly found in the same environmental media as triclosan.

⁵ Includes n-butylparaben and isobutylparaben.

⁶ Fungicides, herbicides, and insecticides are grouped under the general heading of "Pesticides."

⁷ 1-Hydroxynaphthalene is the metabolite of both carbaryl and naphthalene. To determine the percent of 1-hydroxynaphthalene attributable to carbaryl alone, 2-hydroxynaphthalene (which is only a metabolite of naphthalene) must also be measured.

⁸ Includes di-n-butyl phthalate and di-isobutyl phthalate.