

Biomonitoring California Designated Chemicals July 2012

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
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

**Non-Halogenated Aromatic
Phosphates¹**

Bisphenol A bis(diphenyl phosphate)
t-Butylphenyl diphenyl phosphate
2-Ethylhexyl diphenyl phosphate
Isodecyl diphenyl phosphate
Isopropylated triphenyl phosphate
Resorcinol bis(diphenyl phosphate)

Tricresyl phosphate
Triphenyl phosphate

Perchlorate and Other Anions⁶

Perchlorate

Nitrate
Thiocyanate

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, 7}

Carbamate Insecticides³

Benfuracarb
 Carbofuranphenol
Carbaryl
 1-Hydroxynaphthalene⁸
 2-Hydroxynaphthalene⁸
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
Mesosulfuron-methyl
Metsulfuron-methyl
Nicosulfuron
Oxasulfuron
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
Methamidophos
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
Omethoate
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
<u>Pyrethroid Pesticides</u>¹
Allethrin
<i>cis/trans</i> -Dimethylvinylcyclopropane carboxylic diacid
Bifenthrin
Cyfluthrin
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
4-Fluoro-3-phenoxybenzoic acid
Cyhalothrin (including <i>lambda</i> - and <i>gamma</i> -)
3-Phenoxybenzoic acid
Cypermethrin (including <i>cis</i> - and <i>trans</i> -)
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid
Cyphenothrin
Deltamethrin
<i>cis</i> -3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid
Esbiothrin
Esfenvalerate
Etofenprox
Fenpropathrin
3-Phenoxybenzoic acid
Fenvalerate
Imiprothrin
Metofluthrin
Permethrin (including <i>cis</i> - and <i>trans</i> -)
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
<i>trans</i> -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
 Othililone

Phthalates³

Benzylbutyl phthalate (BzBP)
 Mono-benzyl phthalate
 Mono-*n*-butyl phthalate
 Dibutyl phthalate (DBP)⁹
 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-(carboxyoctyl) 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

Phytoestrogens³

Daidzein
 O-Desmethylangolensin
 Equol
 Enterodiol
 Enterolactone
 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)

**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-Octachlorobiphenyl (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
NNK (4-[Methylnitrosamino]-1-[3-pyridyl]-1-butanone)
NNAL (4-[methylnitrosamino]-1-(3-pyridyl)-1-butanol)

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 CDC measures nitrate and thiocyanate along with perchlorate, because all three anions can affect iodine uptake by the thyroid.

⁷ Fungicides, herbicides, and insecticides are grouped under the general heading of "Pesticides."

⁸ 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.

⁹ Includes di-n-butyl phthalate and di-isobutyl phthalate.