

**Biomonitoring California
Priority Chemicals
December 2015**

The following is a list of priority chemicals for Biomonitoring California.^a The Scientific Guidance Panel (SGP) recommends priority chemicals from the designated chemicals list.

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. For some of the parent chemicals listed below, metabolites or other targets for measurement are shown indented underneath. Chemicals are grouped into categories (like “metals” and “pesticides”); some are included in more than one category. The Program determines the chemicals that are actually biomonitored and the appropriate targets for measurement. To jump to each footnote referenced in the list below, click on the relevant number.

Brominated and Chlorinated Organic Compounds used as Flame Retardants ¹

Allyl 2,4,6-tribromophenyl ether (ATE)
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)
2-Bromoallyl-2,4,6-tribromophenyl ether (BATE)
Chlorendic acid
Decabromodiphenylethane (DBDPE)
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane (TBECH)
2,4-Dibromophenol
2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
N,N-Ethylenebis(tetrabromophthalimide)
Hexabromobenzene (HBB)
2,2',4,4',5,5'-Hexabromobiphenyl (BB 153)
Hexabromocyclododecane (HBCD)
Hexachlorocyclopentadienyl-dibromocyclooctane
Isobutoxypentabromocyclododecanes (iBPBCDs)
Octabromotrimethylphenylindane (OBIND)
Pentabromoethylbenzene (PBEB)
Pentabromophenol (PBP)
Pentabromotoluene (PBT)
Short-chain chlorinated paraffins
Tetrabromobisphenol A (TBBPA)
Tetrabromobisphenol A bis(2,3-dibromopropyl) ether
Tetrabromobisphenol A bis(2-hydroxyethyl) ether (TBBPA-DBPE)
Tetrabromophthalic anhydride

2,3,5,6-Tetrabromo-*p*-xylene
2,4,6-Tribromophenol
Tris(2-chloroethyl)phosphate (TCEP)
Tris(1-chloro-2-propyl)phosphate (TCPP)
Tris(2,3-dibromopropyl) isocyanurate
Tris(2,3-dibromopropyl)phosphate (TDBPP)
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',5,6'-Octabromodiphenyl ether (BDE 196)
2,2',3,3',4,4',6,6'-Octabromodiphenyl ether (BDE 197)
2,2',3,3',4,5',6,6'-Octabromodiphenyl ether (BDE 201)
2,2',3,3',5,5',6,6'-Octabromodiphenyl ether (BDE 202)
2,2',3,4,4',5,5',6-Octabromodiphenyl ether (BDE 203)
2,2',3,3',4,4',5,5',6-Nonabromodiphenyl ether (BDE 206)
2,2',3,3',4,4',5,6,6'-Nonabromodiphenyl ether (BDE 207)
2,2',3,3',4,5,5',6,6'-Nonabromodiphenyl ether (BDE 208)

a. California Environmental Contaminant Biomonitoring Program, codified at Health and Safety Code section 105440 et seq.

2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether
(BDE 209)

Hydroxy-PBDEs (Metabolites of PBDEs)

4'-Hydroxy-BDE 17
4-Hydroxy-BDE 42
3-Hydroxy-BDE 47
5-Hydroxy-BDE 47
6-Hydroxy-BDE 47
4'-Hydroxy-BDE 49
2'-Hydroxy-BDE 68
4-Hydroxy-BDE 90
5'-Hydroxy-BDE 99
6'-Hydroxy-BDE 99
3-Hydroxy-BDE 100
5'-Hydroxy-BDE 100
4'-Hydroxy-BDE 101
4'-Hydroxy-BDE 103

Cyclosiloxanes¹

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

Diesel Exhaust²

Diglycidyl Ethers of *p,p'*-Bisphenols¹

Bisphenol A diglycidyl ether (BADGE)
Bisphenol F diglycidyl ether (BFDGE)

Environmental Phenols³

***p,p'*-Bisphenols**¹

Bisphenol A (BPA)
Bisphenol AF (BPAF)
Bisphenol B (BPB)
Bisphenol F (BPF)
Bisphenol S (BPS)
4,4'-Sulfonylbis[2-(2-propen-1-yl)phenol] (TGSA)

Brominated phenols^{3,4}

2,4-Dibromophenol
Pentabromophenol (PBP)
Tetrabromobisphenol-A (TBBPA)
2,4,6-Tribromophenol

Chlorinated phenols^{3,5}

2,4-Dichlorophenol
2,5-Dichlorophenol
Pentachlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Triclosan

Parabens³

Butylparaben⁶
Ethylparaben
Methylparaben
n-Propylparaben

Metals³

Antimony⁷
Arsenic
 Arsenic (V) acid
 Arsenobetaine
 Arsenocholine
 Arsenous (III) acid
 Dimethylarsinic acid
 Monomethylarsonic acid
 Trimethylarsine oxide
Beryllium⁷
Cadmium
Cobalt
Lead
Manganese
Mercury
Molybdenum
Thallium
Tungsten
Uranium

**Non-Halogenated Aromatic
Phosphates**¹

Bisphenol A bis(diphenyl phosphate)
Butylated triphenyl phosphate
t-Butylphenyl diphenyl phosphate
2-Ethylhexyl diphenyl phosphate
Isodecyl diphenyl phosphate
Isopropyl phenyl diphenyl phosphate
Isopropylated triphenyl phosphate
Resorcinol bis(diphenyl phosphate)
Tricresyl phosphate
Triphenyl phosphate

Perchlorate

**Perfluoroalkyl and Polyfluoroalkyl
Substances (PFASs)**^{1,11}

Ammonium 4,8-dioxa-3H-perfluorononanoate
(ADONA)
Bis(perfluorohexyl)phosphinic acid
Bis(perfluorooctyl)phosphinic acid
N-Ethyl-perfluorooctane sulfonamido acetic acid
6:2 Fluorotelomer acetate

8:2 Fluorotelomer acetate
 10:2 Fluorotelomer acetate
 6:2 Fluorotelomer acrylate
 8:2 Fluorotelomer acrylate
 10:2 Fluorotelomer acrylate
 5:3 Fluorotelomer carboxylic acid
 6:2 Fluorotelomer carboxylic acid
 7:3 Fluorotelomer carboxylic acid
 8:2 Fluorotelomer carboxylic acid
 10:2 Fluorotelomer carboxylic acid
 6:2 Fluorotelomer phosphate diester
 6:2/8:2 Fluorotelomer phosphate diester
 8:2 Fluorotelomer phosphate diester
 6:2 Fluorotelomer phosphate monoester
 4:2 Fluorotelomer sulfonic acid
 6:2 Fluorotelomer sulfonic acid
 8:2 Fluorotelomer sulfonic acid
 6:2 Fluorotelomer unsaturated carboxylic acid
 8:2 Fluorotelomer unsaturated carboxylic acid
 10:2 Fluorotelomer unsaturated carboxylic acid
N-Methyl-perfluorooctane sulfonamido) acetic acid
 Perfluorobutane sulfonic acid
 Perfluorobutanoic acid
 Perfluorodecanoic acid
 Perfluorodecylphosphonic acid
 Perfluorododecanoic acid
 Perfluoroethylcyclohexane sulfonic acid
 Perfluoroheptane sulfonic acid
 Perfluoroheptanoic acid
 Perfluorohexadecanoic acid
 Perfluorohexane sulfonic acid
 Perfluorohexanoic acid
 Perfluorohexylperfluorooctylphosphinic acid
 Perfluorohexylphosphonic acid
 Perfluorononane sulfonic acid
 Perfluorononanoic acid
 Perfluorooctadecanoic acid
 Perfluorooctane sulfonamide
 Perfluorooctane sulfonic acid (PFOS)
 Perfluorooctanoic acid (PFOA)
 Perfluorooctylphosphonic acid
 Perfluoropentane sulfonic acid
 Perfluoropentanoic acid
 Perfluorotetradecanoic acid
 Perfluorotridecanoic acid
 Perfluoroundecanoic acid
 Potassium 1,1,2,2,-tetrafluoro-2-({1,1,1,2,3,3-hexafluoro-3-[(trifluorovinyl)oxy]-2-propanyl}oxy)ethanesulfonate tetrafluoroethene
 Sodium bis-[2-(*N*-ethylperfluorooctane-1-sulfonamido)ethyl] phosphate
 Sodium 2-(*N*-ethylperfluorooctane-1-sulfonamido)ethyl phosphate
 2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid

Pesticides ^{3,8}

Herbicides ³

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

Organochlorine Pesticides ³

Dichlorodiphenyltrichloroethane (DDT) (including *p,p'*-DDT and *o,p'*-DDT)
p,p'-Dichlorodiphenyldichloroethene (*p,p'*-DDE)

Organophosphate Insecticides ³

Acephate
 Azinphos methyl
 Dimethyldithiophosphate
 Dimethylphosphate
 Dimethylthiophosphate
 Chlorethoxyphos
 Diethylphosphate
 Diethylthiophosphate
 Chlorpyrifos
 Diethylphosphate
 Diethylthiophosphate
 3,5,6-Trichloro-2-pyridinol (TCPy)
 Chlorpyrifos methyl
 Dimethylphosphate
 Dimethylthiophosphate
 3,5,6-Trichloro-2-pyridinol (TCPy)
 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
Diethyldithiophosphate
Dimethylphosphate
Dimethylthiophosphate
Malathion dicarboxylic acid
Methamidophos
Methidathion
Diethyldithiophosphate
Dimethylphosphate
Dimethylthiophosphate
Methyl parathion
Dimethylphosphate
Dimethylthiophosphate
<i>p</i> -Nitrophenol
Naled
Dimethylphosphate
Oxydemeton-methyl
Dimethylphosphate
Dimethylthiophosphate
Parathion (Ethyl parathion)
Diethylphosphate
Diethylthiophosphate
<i>p</i> -Nitrophenol
Phorate
Diethyldithiophosphate
Diethylphosphate
Diethylthiophosphate
Phosmet (Imidan)
Diethyldithiophosphate
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> ³
Allethrin
<i>cis/trans</i> -Dimethylvinylcyclopropane carboxylic diacid
Cyfluthrin
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>cis</i> -DCCA)
<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>trans</i> -DCCA)
4-Fluoro-3-phenoxybenzoic acid
Cyhalothrin (including <i>lambda</i> - and <i>gamma</i> -)
3-Phenoxybenzoic acid (3-PBA)
Cypermethrin (including <i>cis</i> - and <i>trans</i> -)
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>cis</i> -DCCA)
<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>trans</i> -DCCA)
3-Phenoxybenzoic acid (3-PBA)
Deltamethrin
<i>cis</i> -3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
3-Phenoxybenzoic acid (3-PBA)
Fenpropathrin
3-Phenoxybenzoic acid (3-PBA)
Permethrin (including <i>cis</i> - and <i>trans</i> -)
<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>cis</i> -DCCA)
<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (<i>trans</i> -DCCA)
3-Phenoxybenzoic acid (3-PBA)
Pyrethrin 1
<i>cis/trans</i> -Dimethylvinylcyclopropane carboxylic diacid
Resmethrin
<i>cis/trans</i> -Dimethylvinylcyclopropane carboxylic diacid
Tralomethrin
3-Phenoxybenzoic acid (3-PBA)

Other Pesticides

1,4-Dichlorobenzene (*p*-Dichlorobenzene)
2,5 Dichlorophenol

***ortho*-Phthalates**¹

Benzylbutyl phthalate (BzBP)
 Mono-benzyl phthalate (MBzP)
 Mono-*n*-butyl phthalate (MnBP)
Diallyl phthalate
Di-*n*-butyl phthalate (DnBP)
 Mono-*n*-butyl phthalate (MnBP)
Di-isobutyl phthalate (DIBP)
 Mono-isobutyl phthalate (MIBP)
Dicyclohexyl phthalate (DCHP)
 Mono-cyclohexyl phthalate (MCHP)
Diethyl phthalate (DEP)
 Mono-ethyl phthalate (MEP)
Di-2-ethylhexyl phthalate (DEHP)
 Mono-(2-carboxymethylhexyl) phthalate
 Mono-(2-ethyl-5-carboxypentyl) phthalate (MECPP)
 Mono-2-ethylhexyl phthalate (MEHP)
 Mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP)
 Mono-(2-ethyl-5-oxohexyl) phthalate (MEOHP)
Di-*n*-hexyl phthalate
Di-isodecyl phthalate (DIDP)
 Mono-(carboxynonyl) phthalate (MCNP)
Di-isoheptyl phthalate
Di-isononyl phthalate (DINP)
 Mono-(carboxyoctyl) phthalate (MCOP)
 Mono-(hydroxyisononyl) phthalate
 Mono-isononyl phthalate (MINP)
 Mono-(oxoisononyl) phthalate
Dimethyl phthalate (DMP)
 Mono-methyl phthalate (MMP)
Di-*n*-octyl phthalate (DnOP)
 Mono-(3-carboxypropyl) phthalate (MCP)
 Mono-*n*-octyl phthalate (MnOP)
Di-*n*-pentyl phthalate
Di-2-propylheptyl phthalate
Diundecyl phthalate
Di-isodecyl phthalate
Di-isotridecyl phthalate

**Polychlorinated Biphenyls (PCBs),
Dioxin-Like**³

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-Like**³

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'-Hexachlorobiphenyl (PCB 138)
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)
2,3,3',4,4',6-Hexachlorobiphenyl (PCB 158)
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'-Octachlorobiphenyl (PCB 196)
2,2',3,3',4,5,5',6-Octachlorobiphenyl (PCB 199)
2,2',3,4,4',5,5',6-Octachlorobiphenyl (PCB 203)
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 Biphenyls (PCBs)
Hydroxy-PCBs (Metabolites of PCBs)**

4-Hydroxy-PCB 107
4-Hydroxy-PCB 120
4'-Hydroxy-PCB 130
3'-Hydroxy-PCB 138
4-Hydroxy-PCB 146
3-Hydroxy-PCB 153
4'-Hydroxy-PCB 172

3'-Hydroxy-PCB 180
4-Hydroxy-PCB 187
4'-Hydroxy-PCB 193

**Polycyclic Aromatic Hydrocarbons
(PAHs) [3,10](#)**

3-Hydroxybenzo[a]pyrene
6-Hydroxychrysene
3-Hydroxyphenanthrene

Tobacco Smoke

Nicotine
Cotinine
NNK (4-[Methylnitrosamino]-1-[3-pyridyl]-1-
butanone)
NNAL (4-[Methylnitrosamino]-1-(3-pyridyl)-1-
butanol)

Notes

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

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 priority chemicals; only the specific chemicals listed are priority chemicals.

⁴ These brominated phenols are part of the chemical group “brominated and chlorinated organic compounds used as flame retardants”, which are listed as priority chemicals. The brominated phenols are also included in the category “environmental phenols” because the laboratory measures them with other environmental phenols.

⁵ These chlorinated phenols, with the exception of triclosan, are metabolites of certain pesticides that are listed as priority chemicals. These chlorophenols are also included in the category “environmental phenols” because the laboratory measures them with other environmental phenols.

⁶ Includes *n*-butylparaben and isobutylparaben.

⁷ The SGP recommended that the Program develop methods for antimony and beryllium that meet the Program's quality assurance/quality control (QA/QC) standards.

⁸ Fungicides, herbicides, and insecticides are grouped under the general heading of “Pesticides.”

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

¹⁰ The SGP recommended the three hydroxy-PAHs listed as priority chemicals. These three hydroxy-PAHs are metabolites of benzo[a]pyrene, chrysene and phenanthrene, respectively.

¹¹ A chemical is a perfluoroalkyl substance (also known as a “perfluorochemical”) if all carbon atoms, except for carbon atoms associated with functional groups (such as an aldehyde group), are fully fluorinated. In a polyfluoroalkyl substance, at least one (but not all) of the carbon atoms is fully fluorinated.