

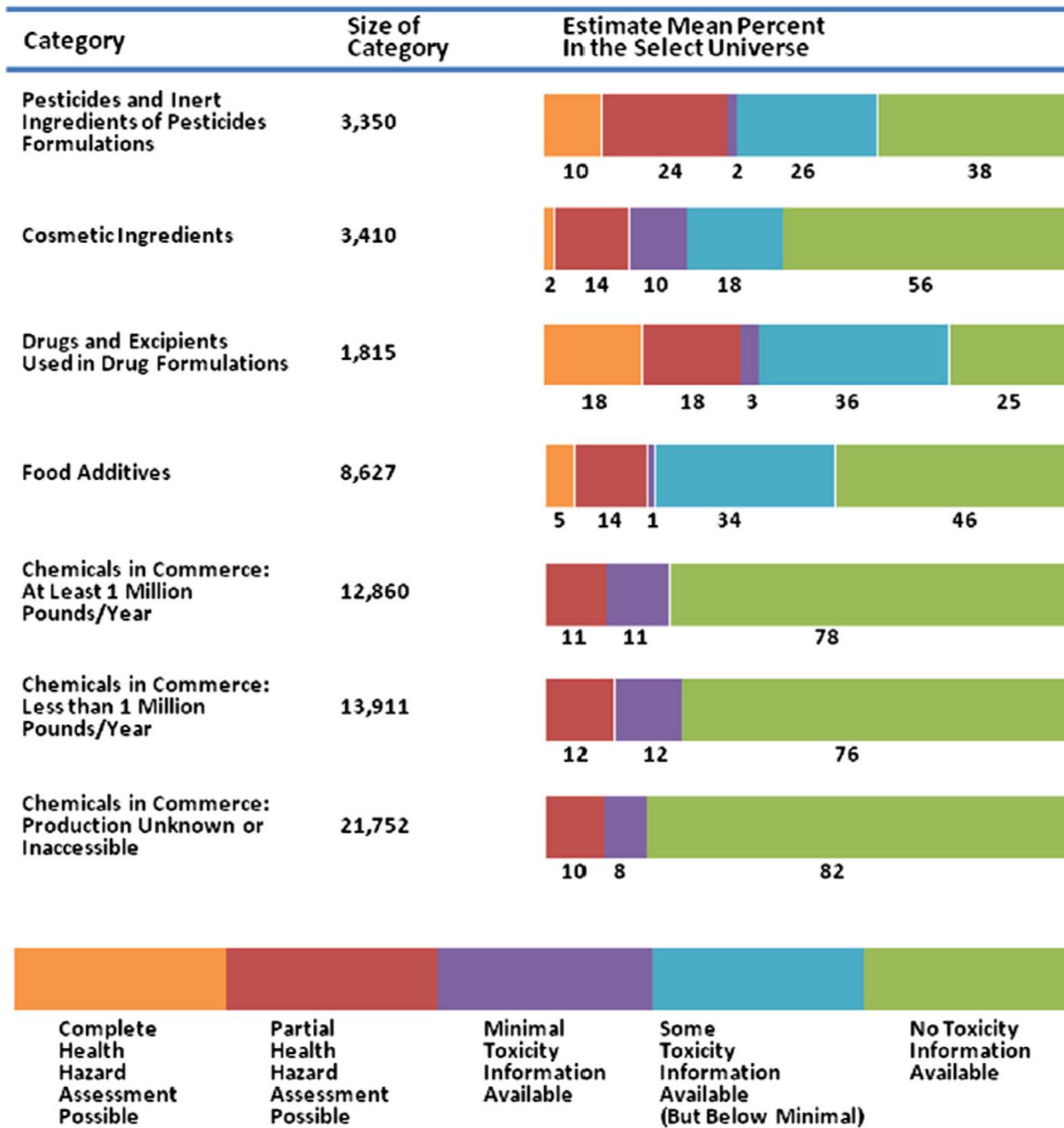
CTD: a resource for predicting chemical-gene-disease networks

*Carolyn Mattingly
North Carolina State University*

Chemical landscape

- > 60,000
- ~2,000 added/year
- ~8,000 are carcinogens
- No toxicity data for ~40% of the 3,300 “high production volume” chemicals
- Full toxicity data for only 25% of chemicals in consumer products





Many disorders are on the rise

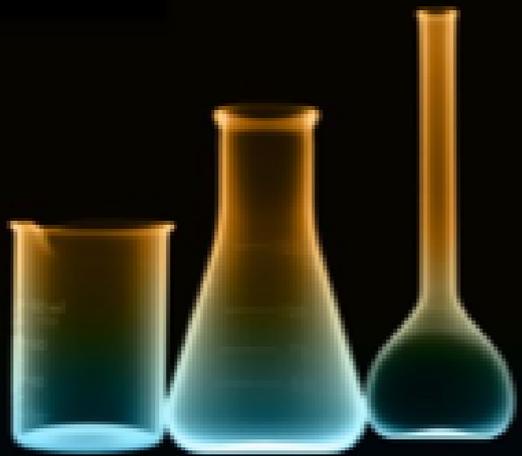
- Leukemia
- Cancers (Brain, breast, childhood)
- Asthma
- Fertility and full term pregnancies
- Birth defects
- Autism





How does the environment affect our health?

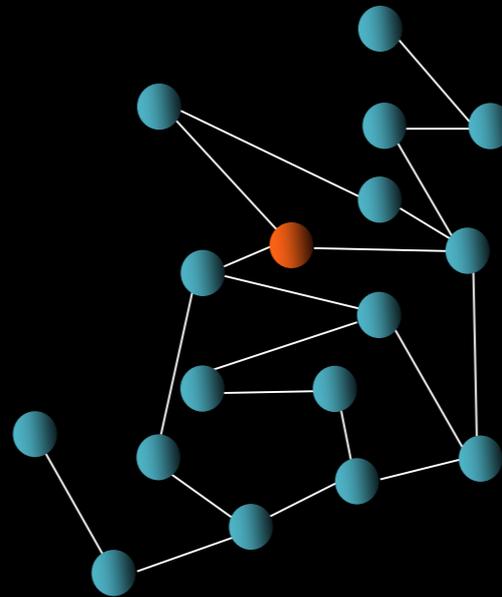


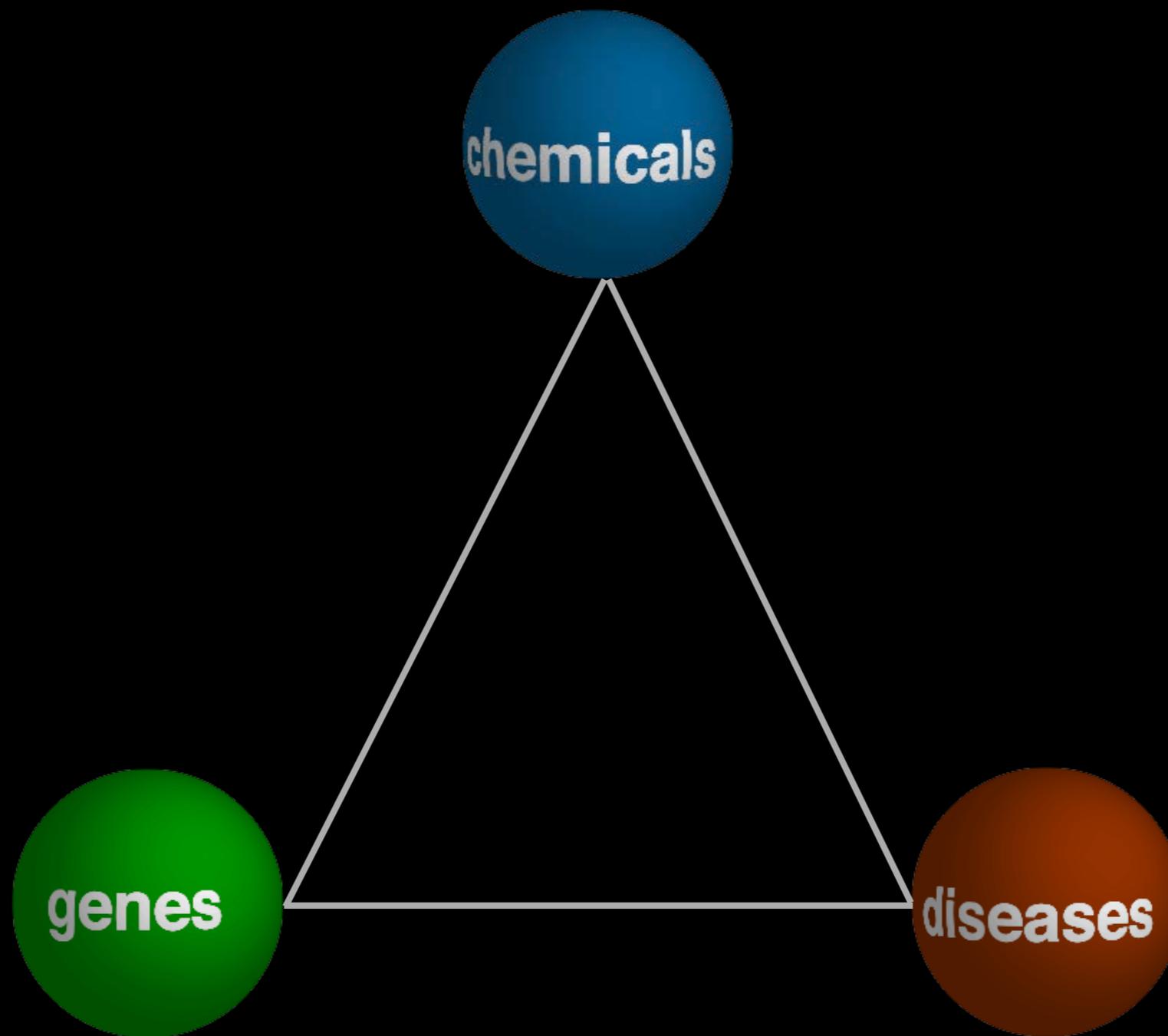


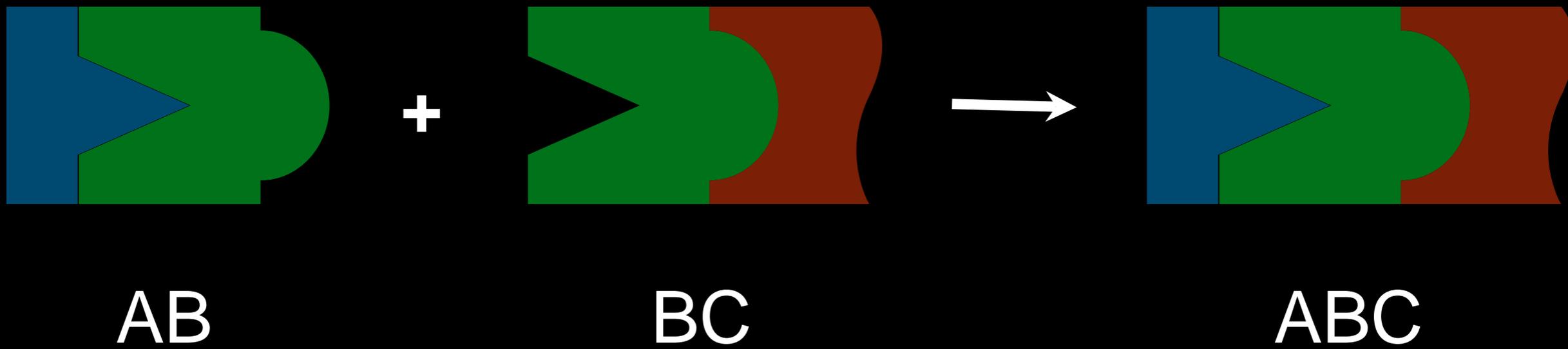
Environment
(chemicals)

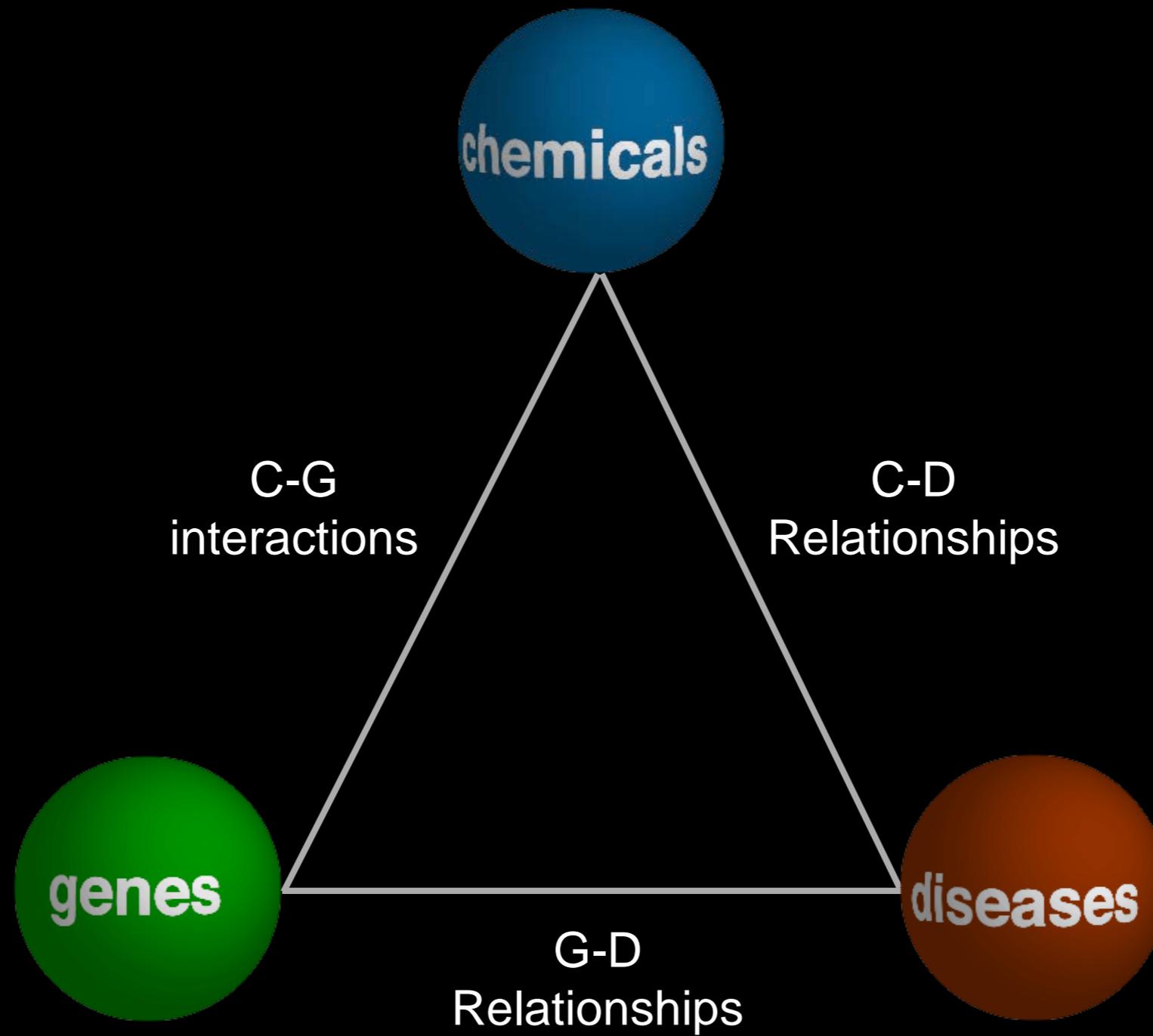


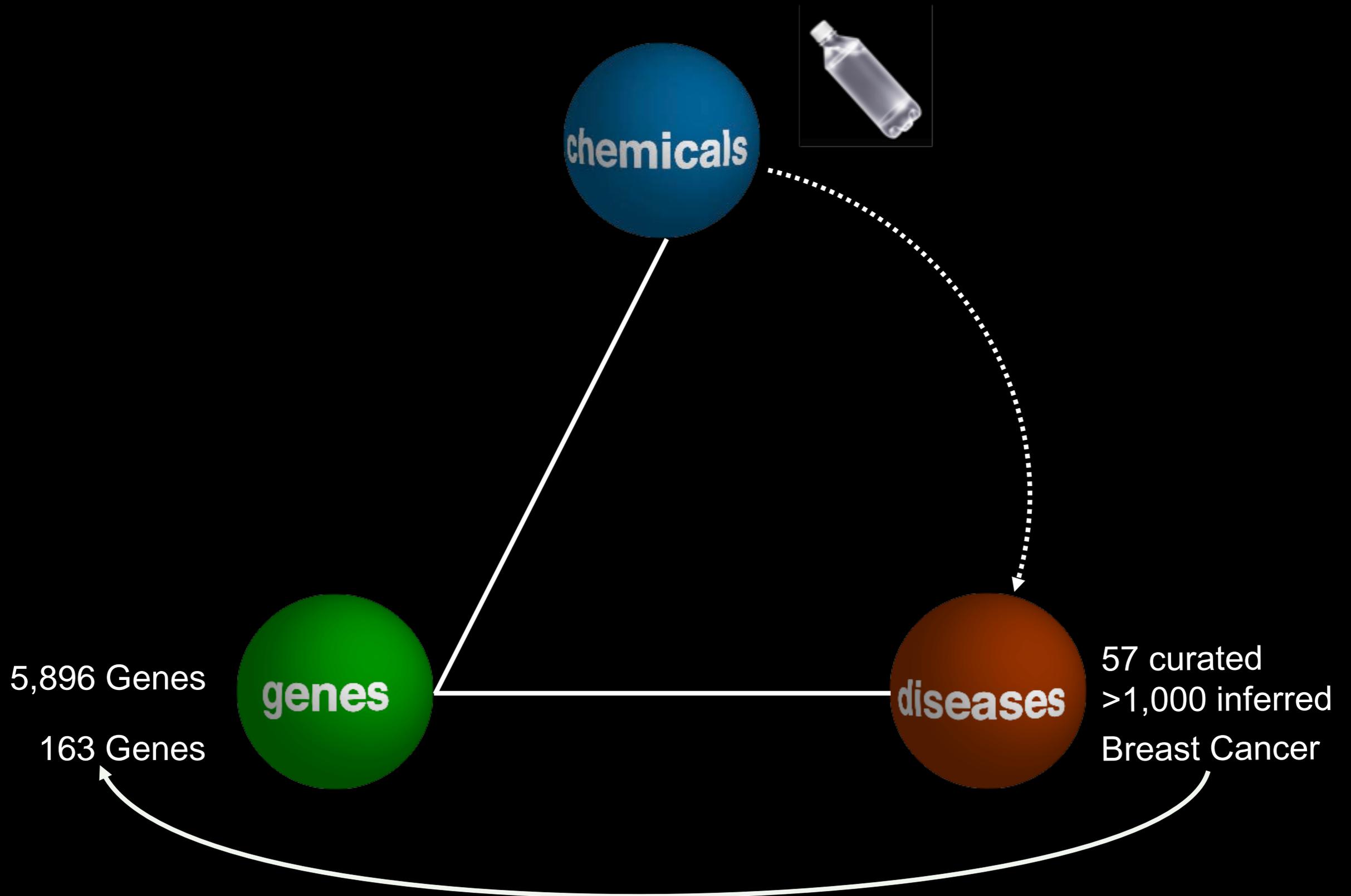
Disease













Giving insight into how chemicals affect our health.

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Comparative Toxicogenomics Database

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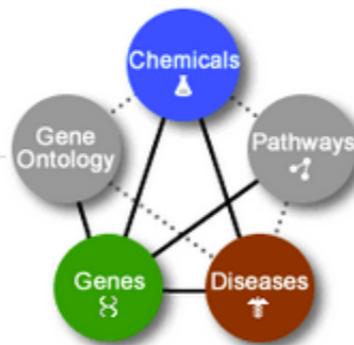
Connect

- Overview
- Chemicals
- Chemical-Gene Interactions
- Genes
- Diseases
- References
- GO
- Pathways
- Organisms

CTD Illuminates

Discover

1. What health effects are associated with a [gene/protein](#)? ([Example](#))
2. What health effects are associated with a [chemical](#)? ([Example](#))
3. What genes/proteins interact with a [chemical](#)? ([Example](#))
4. What cellular functions (GO terms) are affected by a [gene/protein](#)? ([Example](#))
5. What cellular functions (GO terms) are affected by a [chemical-gene/protein interaction](#)? ([Example](#))
6. What cellular functions (GO terms) are affected by a [chemical](#)? ([Example](#))



16,241,275 TOXICOGENOMIC RELATIONSHIPS!

Keyword Search

[Advanced searches](#)

Updated Chemicals

[\(4-amino-1,4-dihydro-3-\(2-pyridyl\)-5-thioxo-1,2,4-triazole\)copper\(II\) 2',3,3',4',5-pentachloro-4-hydroxybiphenyl 4-hydroxy-2-nonenal Cadmium Cadmium Chloride cadmium sulfate cobaltiprotoporphyryn cobaltous chloride Copper Copper Sulfate cupric chloride Cisplatin Ethanol Hydrogen Peroxide Iron lead acetate lead nitrate Lipopolysaccharides Mercuric Chloride Mercury Oxygen Streptozocin Tetradecanoylphorbol Acetate Tretinoin vinclozolin](#)

Updated Diseases

Updated Genes

News

- ▶ August 7, 2012
New data available!
- ▶ July 19, 2012
You can now create custom similarity analyses for ChemComps and GeneComps!
- ▶ May 8, 2012
Use our new [Gene Set Enricher](#) tool to find GO functional annotations or pathways that are enriched for a set of genes.
- ▶ January 9, 2012
Use our new [MyVenn](#) tool to view relationships among your own data sets.
- ▶ November 7, 2011
We have a new URL! <http://ctdbase.org/>
- ▶ September 15, 2011
[Exposure](#) data is coming.
- ▶ [All changes...](#)

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Our Latest Publication

- ▶ Hirschman L, Burns GA, Krallinger M, Arighi C, Cohen KB, Valencia A, Wu CH, Chatr-Aryamontri A, Dowell KG, Huala E, Lourenço A, Nash R, Veuthey AL, Wieggers T, Winter AG.
Text mining for the biocuration workflow.
Database (Oxford). 2012 Apr 18;2012:bas020. Print 2012. [[PMID:22513129](#)]
- ▶ [All CTD publications...](#)

Chlorpyrifos

Basics Interactions Genes Diseases ChemComps Pathways GO References Links

Name **Chlorpyrifos**

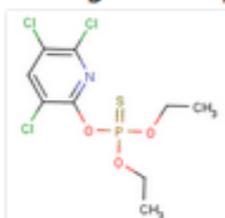
CAS Type 1 Name Phosphorothioic acid, O,O-diethyl O-(3,5,6-trichloro-2-pyridinyl) ester

Equivalent Terms Dursban · Lorsban

CAS Registry Number 2921-88-2

Definition An organothiophosphate cholinesterase inhibitor that is used as an insecticide and as an acaricide.

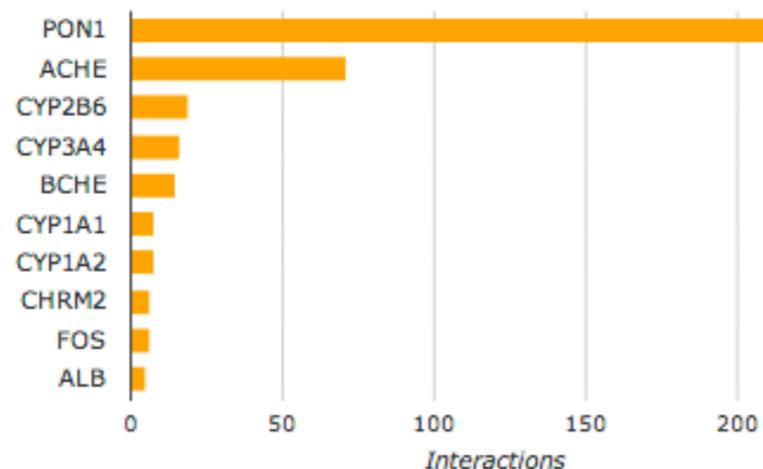
Chemical Drawing



MeSH® ID D004390

Curator Note For additional curated data about phosphorus, please also see [Phosphorus](#) and its chemical descendants.

Top Interacting Genes



Ancestors

Top ↑

1. Chemicals ← Organic Chemicals ⌘ ⚡ ← Organophosphorus Compounds ⌘ ⚡ ← Organophosphates ⌘ ⚡ ← Organothiophosphates ⌘ ⚡ ← Chlorpyrifos ⌘ ⚡
2. Chemicals ← Organic Chemicals ⌘ ⚡ ← Organophosphorus Compounds ⌘ ⚡ ← Organothiophosphorus Compounds ⌘ ⚡ ← Organothiophosphates ⌘ ⚡ ← Chlorpyrifos ⌘ ⚡
3. Chemicals ← Organic Chemicals ⌘ ⚡ ← Sulfur Compounds ⌘ ⚡ ← Organothiophosphorus Compounds ⌘ ⚡ ← Organothiophosphates ⌘ ⚡ ← Chlorpyrifos ⌘ ⚡

Descendants

Top ↑

Chlorpyrifos ⌘ ⚡

chlorpyrifos-methyl ⌘ ⚡

O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate ⌘ ⚡

Chlorpyrifos

- Basics
- Interactions**
- Genes
- Diseases
- ChemComps
- Pathways
- GO
- References
- Links

1-100 of 1,901 results.

◀ First ◀ Previous 1 2 3 4 5 6 7 8 ▶ Next ▶ Last

	Interacting Chemical	Interacting Gene	Interaction	References	Organisms
1.	Chlorpyrifos	ABCA1A	Chlorpyrifos results in increased expression of ABCA1A mRNA	1	1
2.	Chlorpyrifos	ABCA1A	[Copper co-treated with Chlorpyrifos] results in increased expression of ABCA1A mRNA	1	1
3.	Chlorpyrifos	ABCA5	[Copper co-treated with Chlorpyrifos] results in decreased expression of ABCA5 mRNA	1	1
4.	Chlorpyrifos	ABCB1	Chlorpyrifos binds to ABCB1 protein	1	1
5.	Chlorpyrifos	ABCB1	Chlorpyrifos inhibits the reaction [ABCB1 protein results in increased export of Doxorubicin]	1	1
6.	chlorpyrifos-methyl			1	1
7.	chlorpyrifos-methyl			1	1
8.	Chlorpyrifos			1	1
9.	Chlorpyrifos			1	1
10.	Chlorpyrifos			1	1
11.	Chlorpyrifos			1	1
12.	Chlorpyrifos	ABCG8	Chlorpyrifos results in increased expression of ABCG8 mRNA	1	1
13.	Chlorpyrifos	ABHD2B	[Copper co-treated with Chlorpyrifos] results in decreased expression of ABHD2B mRNA	1	1
14.	Chlorpyrifos	ABI3BP	Chlorpyrifos results in increased expression of ABI3BP mRNA	1	1
15.	Chlorpyrifos	ACACA	[Copper co-treated with Chlorpyrifos] results in increased expression of ACACA mRNA	1	1
16.	Chlorpyrifos	ACAT2	Chlorpyrifos results in increased expression of ACAT2 mRNA	1	1
17.	Chlorpyrifos	ACAT2	[Copper co-treated with Chlorpyrifos] results in increased expression of ACAT2 mRNA	1	1
18.	Chlorpyrifos	ACCN2	Chlorpyrifos results in decreased expression of ACCN2 mRNA	1	1
19.	Chlorpyrifos	ACE1	ACE1 gene mutant form results in decreased susceptibility to Chlorpyrifos	1	1
20.	Chlorpyrifos	ACE-1	ACE-3 protein inhibits the reaction [Chlorpyrifos results in decreased activity of ACE-1 protein]	1	1
21.	Chlorpyrifos	ACE-1	Chlorpyrifos results in decreased activity of ACE-1 protein	1	1
22.	Chlorpyrifos	ACE-2	ACE-3 protein inhibits the reaction [Chlorpyrifos results in decreased activity of ACE-2 protein]	1	1
23.	Chlorpyrifos	ACE-2	Chlorpyrifos results in decreased activity of ACE-2 protein	1	1
24.	Chlorpyrifos	ACE-3	ACE-3 protein inhibits the reaction [Chlorpyrifos results in decreased activity of ACE-1 protein]	1	1
25.	Chlorpyrifos	ACE-3	ACE-3 protein inhibits the reaction [Chlorpyrifos results in decreased activity of ACE-2 protein]	1	1



1-100 of 1,167 results.

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	Interacting Gene	Interactions	Organisms
1.	PON1	240	3
2.	ACHE	71	15
3.	CYP2B6	19	2
4.	CYP3A4	16	1
5.	BCHE	15	3
6.	CYP1A1	8	4
7.	CYP1A2	8	1
8.	CHRM2	6	2
9.	FOS	6	2
10.	ALB	5	1
11.	CYP2C19	5	1
12.	SOD1	5	3
13.	ABCB1	4	1
14.	ADRBK1	4	1
15.	AHR	4	3
16.	ATP2B2	4	2
17.	CAT	4	2
18.	CNR1	4	1
19.	DLG4	4	2
20.	GNRH1	4	2
21.	GRM2	4	2
22.	HSP70	4	3
23.	NCAM1	4	3
24.	NDUFB3	4	3
25.	NDUFB4	4	3
26.	NLGN2	4	2
27.	NR1I2	4	2
28.	NR1I3	4	2
29.	SEMA4F	4	3
30.	SNAPIN	4	3
31.	SYN2	4	2
32.	TNR	4	3

Chlorpyrifos

Basics Interactions Gene

These diseases are associated (via a curated gene interaction)

Disease categories [\[Show chart\]](#)



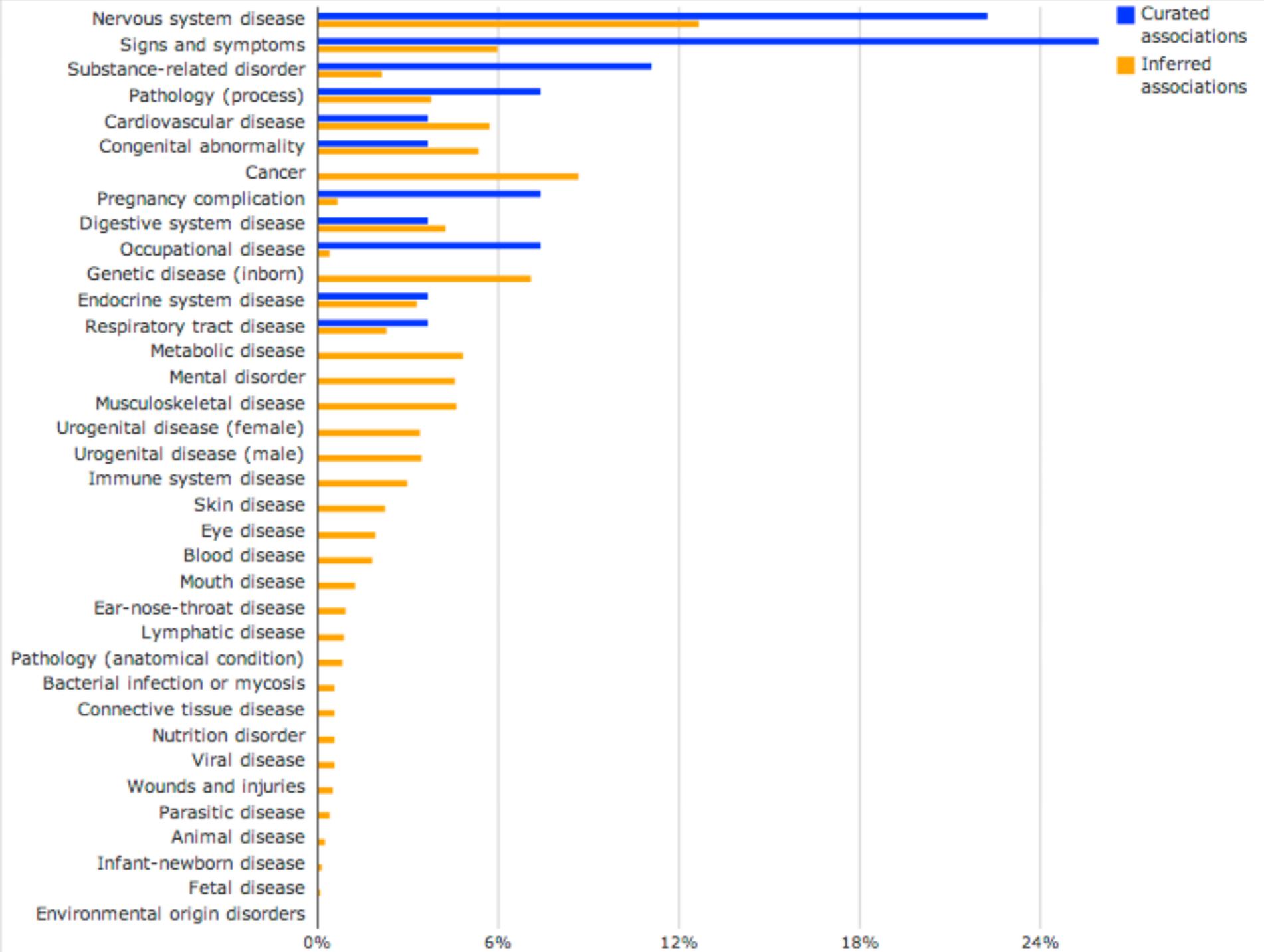
Filter by Disease category
All categories

1-100 of 1,328 results.

First Previous 1 2 3 4 5

	Chemical	Disease
1.	Chlorpyrifos	Nervous System Diseases
2.	Chlorpyrifos	Neurotoxicity Syndrome
3.	Chlorpyrifos	Liver Disease
4.	Chlorpyrifos	Brain Disease
5.	Chlorpyrifos	Persian Gulf Syndrome
6.	Chlorpyrifos	Weight Loss
7.	Chlorpyrifos	Fetal Death
8.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Poisoning
9.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Hypothermia
10.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Nervous System Diseases

Disease categories [\[Hide chart\]](#)



inferred

References

19

10

20

2

2

3

3

6

2

2 genes: ACHE · PNPLA6

3.09

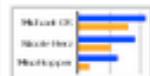
4

Chlorpyrifos

Basics Interactions Genes **Diseases** ChemComps Pathways GO References Links

These diseases are associated with *Chlorpyrifos* or its descendants. Each association is *curated* (**M** marker/mechanism and/or **T** therapeutic) and/or *inferred* (via a curated gene interaction).

Disease categories [\[Show chart\]](#)



Filter by Disease category: Association type:

1-100 of 1,328 results.

◀ First ◀ Previous 1 2 3 4 5 6 7 8 ▶ Next ▶ Last

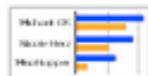
	Chemical	Disease	Direct Evidence	Enrichment Analysis	Inference Network	Inference Score	References
1.	Chlorpyrifos	Nervous System Diseases	M	GO ↗	17 genes: ABCB1 · ABCG2 · ACHE · ADRB2 · ATF3 · BDNF · CASP3 · CASP9 · FOS · GFAP · NGF · PENK · SEPP1 · SLC18A2 · SLC6A3 · SOD1 · TNF	7.77	19
2.	Chlorpyrifos	Neurotoxicity Syndromes	M	GO ↗	10 genes: ABCB1 · BCHE · BCL2L1 · CCK · CYP3A5 · FOS · NFE2L2 · NQO1 · PON1 · TIMP3	5.04	10
3.	Chlorpyrifos	Liver Diseases	M	GO ↗	13 genes: AHR · ALPL · BCL2L1 · CCK · CYP1A2 · HMOX1 · NQO1 · SC5DL · SERPINA1 · SOCS1 · SOD1 · TIMP3 · TNF	4.73	20
4.	Chlorpyrifos	Brain Diseases	M		1 gene: TH	3.96	2
5.	Chlorpyrifos	Persian Gulf Syndrome	M		1 gene: PON1	3.70	2
6.	Chlorpyrifos	Weight Loss	M	GO ↗	2 genes: CRH · OXT	3.57	3
7.	Chlorpyrifos	Fetal Death	M	GO ↗	2 genes: LPAR1 · OXT	3.31	3
8.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Poisoning	M	GO ↗	2 genes: ACHE · BCHE	3.10	6
9.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Hypothermia	M		1 gene: CNR1	3.09	2
10.	O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphate	Nervous System Diseases	M	GO ↗	2 genes: ACHE · PNPLA6	3.09	4

Chlorpyrifos

Basics Interactions Genes **Diseases** ChemComps Pathways GO References Links

These diseases are associated with *Chlorpyrifos* or its descendants. Each association is *curated* (M marker/mechanism and/or T therapeutic) and/or *inferred* (via a curated gene interaction).

Disease categories [\[Show chart\]](#)



Filter by

Disease category: All categories
 Animal disease
 Bacterial infection or mycosis
 Blood disease
 Cancer

Association type: All types
 curated
 inferred

1-100 of 1,300

First Previous Next Last

Chemical	Disease	Direct Evidence	Enrichment Analysis	Inference Network	Inference Score	References
1. Chlorpyrifos	Prostatic Neoplasms			54 genes: ACHE · ADRB2 · AR · ATF3 · ATM · BAX · CALR · CASP9 · CCND1 · CCND2 · CDH1 · CDH13 · CDKN1B · COMT · CRYAB · CSRP1 · CTNNB1 · CTSB · CYP1A1 · CYP3A4 · CYP3A5 · EIF3A · ESR1 · FGF2 · FGFR4 · GADD45A · GSK3B · GSTA1 · GSTK1 · GSTM1 · GSTM3 · GSTO1 · GSTT1 · IGF1 · IL6 · LPAR1 · LPL · MYC · NQO1 · PDIA3 · PENK · PON1 · PPP3CA · RNASE4 · RPL10 · RPN2 · SEPP1 · SLC12A2 · SOD2 · TGFA · TGFB1 · TNFSF10 · TOP2A · TP53	42.13	68
2. Chlorpyrifos	Autistic Disorder			36 genes: ADRB2 · AR · AVPR1A · BDNF · CACNA1C · CAT · CHRNA7 · CHRN2 · COMT · DHCR7 · DLGAP2 · EGR2 · GPX1 · GRIA1 · GRIK2 · GRIN2A · GSTM1 · HTR1B · HTR1D · HTR2A · HTR5A · IGF1 · IL13 · IL6 · MEF2C · NRCAM · NTF3 · NTRK2 · OXT · OXTR · PON1 · ROBO2 · RPL10 · SLC6A4 · SLC6A8 · WNT2	35.71	46
3. Chlorpyrifos	Carcinoma, Hepatocellular			41 genes: ABCB1 · ACACA · AR · ATM · BCL2L1 · BTG2 · CCNA1 · CCND1 · CDH13 · CEBPA · CEBPB · COMT · CTNNB1 · CYP1A1 · CYR61 · ESR1 · FOS · GPC3 · GSTM1 · HSPA5 · IGF2R · IL6 · KRAS · MED1 · MYC · NFE2L2 · PDGFRL · PDIA3 · PRDX6 · PTK2 · SCD · SERPINA1 · SKP2 · SLIT2 · SOD2 · TGFA · TGFB1 · TH · TNFSF10 · TP53 · USP2	35.27	43
4. Chlorpyrifos	Breast Neoplasms			51 genes: ABCG2 · AHR · AR · ATM · BAG1 · BAX · CASP7 · CCND1 · CDH1 · CDKN1B · COMT · CTNNB1 · CYP1A1 · CYP2B1 · CYP2D6 · CYP3A4 · DKK1 · EDNRB · ESR1 · FGFR2 · FOS · GPX1 · GPX2 · GPX4 · HMOX1 · HP · HSP90AA1 · IGF1 · IGFBP5 · IL1B · IL6 · KDR · KIT · KRAS · KRT18 · LLGL1 · LPAR1 · MTDH · NOTCH1 · NQO1 · NRCAM · RGS2 · RRAD · SFRP5 · SOD2 · TGM2 · TNF · TNFSF10 · TOP2A · TP53 · WNT10B	32.71	63
5. Chlorpyrifos	Schizophrenia			31 genes: BDNF · CAMK2B · CELF2 · COMT · DLG1 · DRD2 · DRD4 · EIF5 · GABRB2 · GRIK2 · GRIK5 · GRIN2B · GRM2 · GSK3B · HP · HTR2A · HTR6 · HTR7 · IL1B · IL6 · KDR · NTF3 · NTRK1 · OXTR · RTN4 · SLC6A3 · SLC6A4 · TAC1 · TNF · TP53 · TPH1	30.05	31

Chlorpyrifos

Basics Interaction

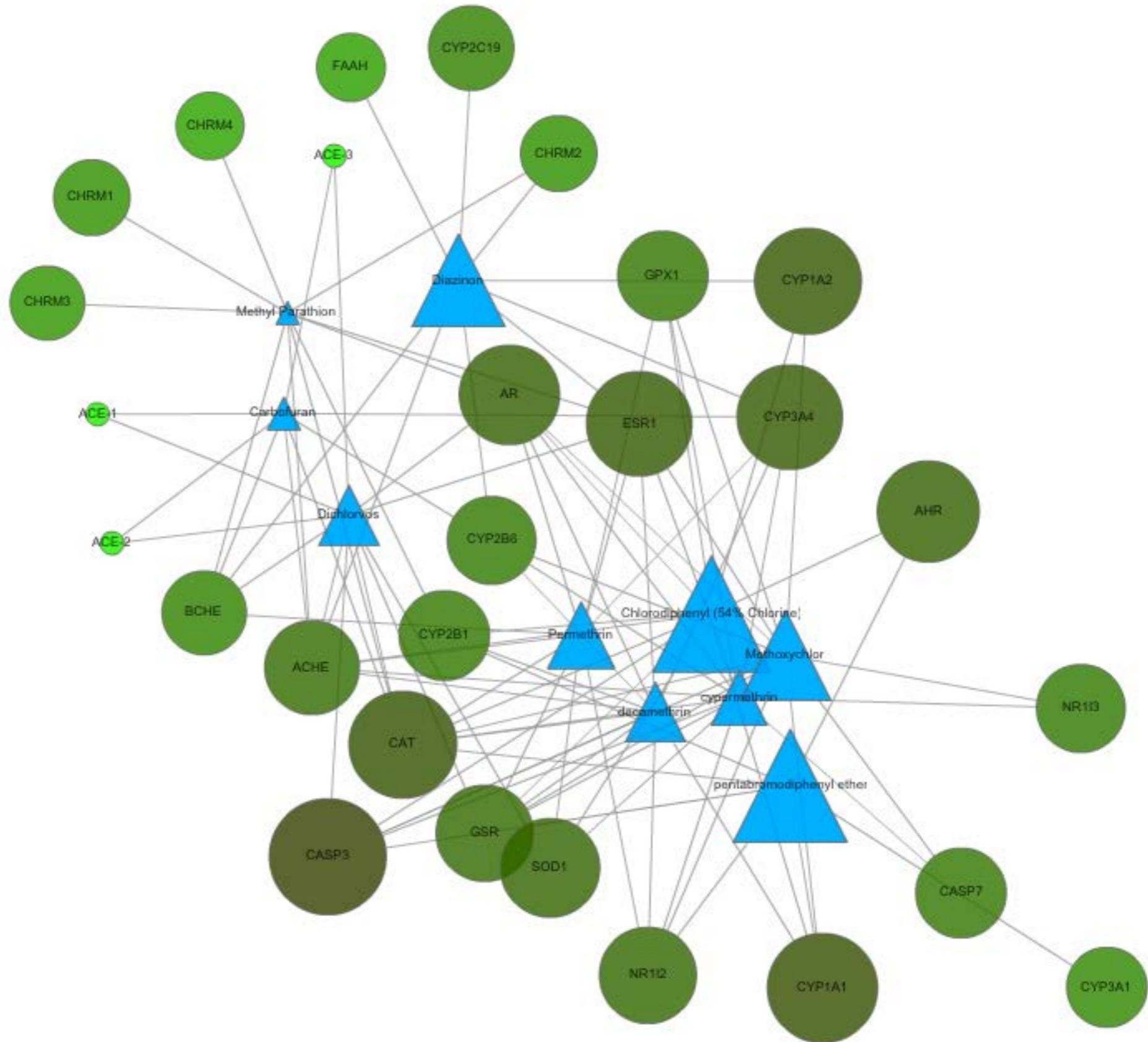
These chemicals hav

Filter by interaction type

- Increases
- decreases
- affects (degree unspecified)

- all (unfiltered)
- activity
- binding
- expression

Pathway view of top



Methyl
cyp
Chlorodiph

de

Methyl

pentabromodiph

Chlor

Plar
alpha-hexachlorocy

I
O

Download: [CSV](#) | [XGMML](#)

Pathway view of top 10 Comps: [XGMML](#)

Chlorpyrifos

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These pathways are enriched significantly among genes that interact with *Chlorpyrifos* or its descendants. We show only terms with a corrected p-value less than 0.01.

1-100 of 109 results.

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	Pathway	Pathway ID	P-value	Corrected P-value	Annotated Genes	Genome Frequency
1.	Metabolism	REACT:111217	1.57e-84	4.64e-82	167	1362/34680 genes: 3.93%
2.	Signal Transduction	REACT:111102	6.89e-69	2.03e-66	162	1614/34680 genes: 4.65%
3.	Neuroactive ligand-receptor interaction	KEGG:04080	1.36e-63	4.01e-61	80	326/34680 genes: 0.94%
4.	Pathways in cancer	KEGG:05200	8.72e-51	2.57e-48	70	332/34680 genes: 0.96%
5.	Huntington's disease	KEGG:05016	1.25e-45	3.70e-43	53	189/34680 genes: 0.54%
6.	Alzheimer's disease	KEGG:05010	1.27e-42	3.73e-40	49	172/34680 genes: 0.50%
7.	Neuronal System	REACT:13685	1.27e-41	3.76e-39	58	281/34680 genes: 0.81%
8.	Metabolic pathways	KEGG:01100	7.25e-39	2.14e-36	106	1207/34680 genes: 3.48%
9.	Glutamatergic synapse	KEGG:04724	2.45e-36	7.24e-34	40	131/34680 genes: 0.38%
10.	MAPK signaling pathway	KEGG:04010	6.82e-35	2.01e-32	52	281/34680 genes: 0.81%
11.	Parkinson's disease	KEGG:05012	7.87e-35	2.32e-32	39	132/34680 genes: 0.38%
12.	Melanogenesis	KEGG:04916	1.01e-34	2.98e-32	36	106/34680 genes: 0.31%
13.	Calcium signaling pathway	KEGG:04020	2.48e-31	7.32e-29	41	182/34680 genes: 0.52%
14.	Axon guidance	KEGG:04360	9.94e-31	2.93e-28	36	133/34680 genes: 0.38%
15.	Oxidative phosphorylation	KEGG:00190	3.57e-28	1.05e-25	34	133/34680 genes: 0.38%
16.	Immune System	REACT:6900	4.36e-28	1.29e-25	84	1044/34680 genes: 3.01%
17.	Disease	REACT:116125	2.10e-27	6.20e-25	73	812/34680 genes: 2.34%
18.	Amyotrophic lateral sclerosis (ALS)	KEGG:05014	5.84e-27	1.72e-24	24	54/34680 genes: 0.16%
19.	Glutathione metabolism	KEGG:00480	5.84e-27	1.72e-24	24	54/34680 genes: 0.16%
20.	Developmental Biology	REACT:111045	9.34e-27	2.75e-24	52	408/34680 genes: 1.18%
21.	Wnt signaling pathway	KEGG:04310	2.33e-26	6.88e-24	35	161/34680 genes: 0.46%
22.	Drug metabolism - cytochrome P450	KEGG:00982	1.07e-25	3.15e-23	26	75/34680 genes: 0.22%
23.	Hemostasis	REACT:604	6.01e-24	1.77e-21	53	487/34680 genes: 1.40%
24.	Metabolism of xenobiotics by cytochrome P450	KEGG:00980	1.62e-23	4.77e-21	24	71/34680 genes: 0.20%
25.	Regulation of actin cytoskeleton	KEGG:04810	1.76e-23	5.19e-21	37	222/34680 genes: 0.64%
26.	Basal cell carcinoma	KEGG:05217	3.39e-20	9.99e-18	20	57/34680 genes: 0.16%
27.	Transmembrane transport of small molecules	REACT:15518	5.94e-19	1.75e-16	44	432/34680 genes: 1.25%
28.	Thyroid cancer	KEGG:05216	6.57e-17	1.94e-14	14	29/34680 genes: 0.08%
29.	Long-term potentiation	KEGG:04720	7.21e-17	2.13e-14	19	70/34680 genes: 0.20%
30.	Melanoma	KEGG:05218	9.66e-17	2.85e-14	19	71/34680 genes: 0.20%

Chlorpyrifos

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These GO terms are enriched significantly among genes that interact with *Chlorpyrifos* or its descendants. We show only terms with a corrected p-value less than 0.01.

Filter by Ontology:
Highest GO level:

1-100 of 778 results.

	Ontology	Highest GO Level	GO Term	P-value	Corrected P-value	Annotated Genes	Genome Frequency
1.	BP	4	nervous system development	1.80e-129	1.51e-125	266	1686/34817 genes: 4.84%
2.	BP	4	neurological system process	4.14e-105	3.46e-101	208	1231/34817 genes: 3.54%
3.	BP	4	synaptic transmission	1.35e-101	1.13e-97	156	649/34817 genes: 1.86%
4.	BP	4	cell surface receptor signaling pathway	1.91e-94	1.60e-90	263	2293/34817 genes: 6.59%
5.	BP	4	neurogenesis	3.13e-78	2.61e-74	170	1108/34817 genes: 3.18%
6.	BP	4	phosphate-containing compound metabolic process	2.62e-77	2.19e-73	193	1472/34817 genes: 4.23%
7.	BP	5	phosphorylation	1.81e-76	1.51e-72	178	1255/34817 genes: 3.60%
8.	BP	5	generation of neurons	3.21e-76	2.68e-72	163	1041/34817 genes: 2.99%
9.	BP	4	neuron differentiation	1.78e-72	1.48e-68	153	960/34817 genes: 2.76%
10.	BP	4	cellular response to organic substance	1.64e-65	1.37e-61	156	1120/34817 genes: 3.22%
11.	BP	4	cellular protein metabolic process	2.44e-64	2.04e-60	267	3234/34817 genes: 9.29%
12.	BP	4	apoptotic process	3.17e-	2.65e-58	177	1527/34817 genes: 4.39%



Illuminating how chemicals affect human

Comparative Toxicogenomics Database

Home

Search

Analyze

Download

Analysis Tools

[Batch Query](#)

Download custom data associated with your query or references.

[Set Analyzer](#)

Perform analyses such as set-based enrichment for collections of chemicals or genes, and pathway generation for collections of genes.

[MyGeneVenn](#)

Compare your gene list to gene sets.

[MyVenn](#)

View relationships among your data.

[VennViewer](#)

Compare associated data sets for your query.

Set Analyzer

Perform analyses such as set-based enrichment for collections of chemicals or genes, and pathway generation for collections of genes.

1 Select your input type

- Chemicals (MeSH[®] names, synonyms, or IDs, or CAS RNs)
- Genes (NCBI symbols or IDs)

2 Enter your data set

Return -, tab- or | -delimited

3 Choose the analysis

- Enriched diseases
- Enriched GO functional annotations
 - Ontology
 - All
 - Biological Process
 - Molecular Function
 - Cellular Component
- Enriched pathways
- Common gene-gene interactions

4 Configure the analysis

P-value

Threshold: (0-1.0)

- Corrected (recommended)
- Raw

Submit

Clear

CTD Data (June 2013)	Status
Curated Chemicals	12,985
Curated Genes	32,464
Curated Diseases	6,354
Chemical-Gene Interactions	869,902
Unique Chemicals	10,150
Unique Genes	31,344
Unique Organisms	492
Curated Gene-Disease Relationship	27,397
Curated Chemical-Disease Relationships	186,986

>300 manuscripts using CTD data

>30 public databases incorporating CTD data

Exposure data

- Grounding CTD data in “real-world” exposure data
- Centralizing exposure data
- Integrating exposure information with other biological data



EXO

Exposure Stressor

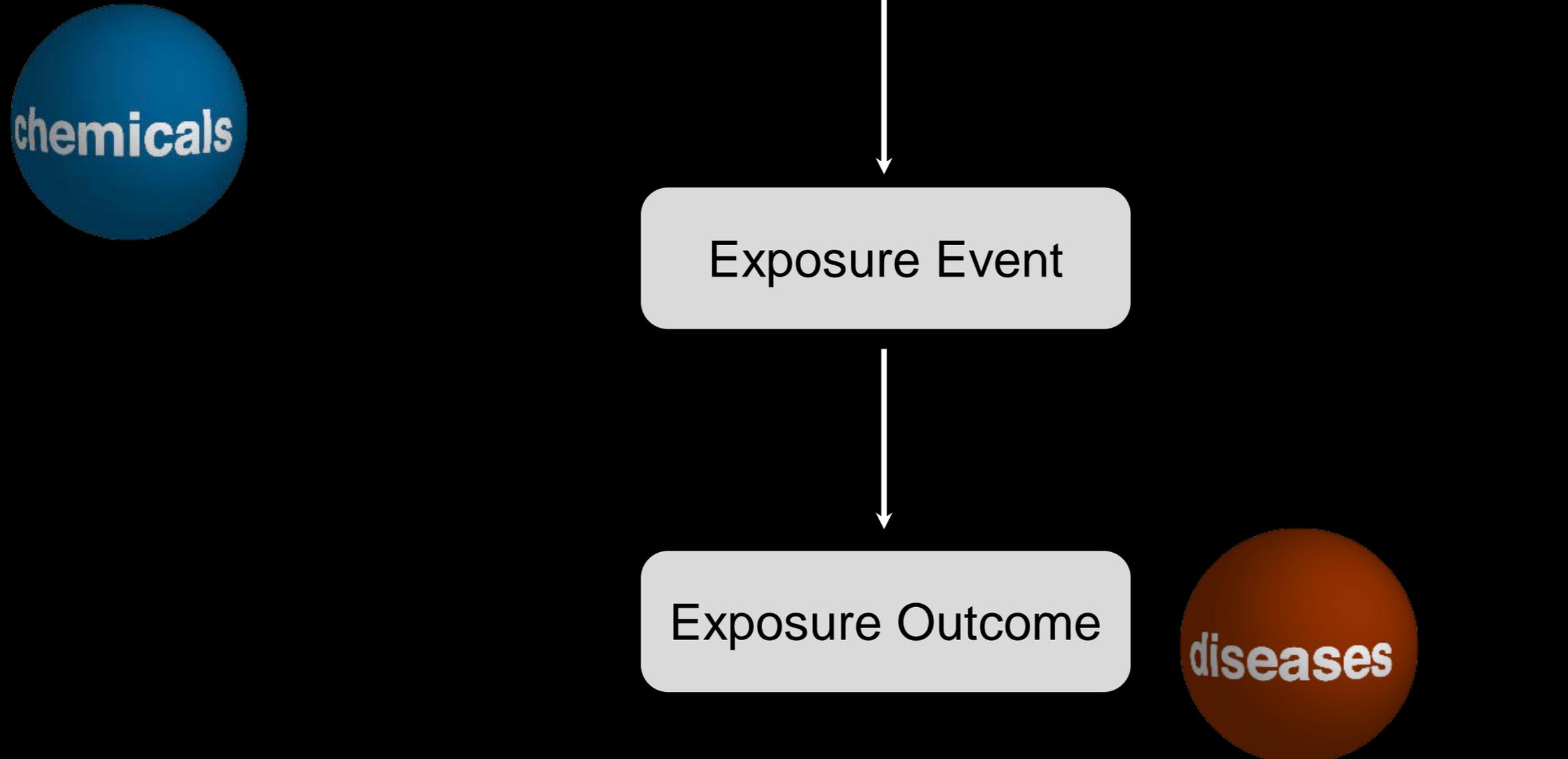
Interacts with

Exposure Receptor



Exposure Event

Exposure Outcome



Exposure data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	CURATION IDENTIFIERS		STUDY IDENTIFIERS		EXPOSURE STRESSOR			EXPOSURE RECEPTOR			EXPOSURE EVENT				EXPOSURE OUTCOME		SUMMARY
2	4 fields		4 fields		6 fields			15 fields			17 fields				6 fields		2 fields
3	Curator	PMID	Study Title	Collection Years	Stressor Agent	Source	Number Samples	Age	Gender	Race	Methods	Limits of Detection	Assay Value	Event Location	Disease	Phenotype	Comments
4	cmurphy	22264316		1969-1990	Tetrachloroethylene	Dietary	1512	29.3 years	M/F	98.5% White				Cape Cod, MA	Bipolar Disorder		Results provide support for an in
5	cmurphy	22264316		1969-1990	Tetrachloroethylene	Dietary	1512	29.3 years	M/F	98.5% White				Cape Cod, MA	Stress Disorders, Post-Traumatic		Results provide support for an in
6	cmurphy	22264316		1969-1990	Tetrachloroethylene	Dietary	1512	29.3 years	M/F	98.5% White				Cape Cod, MA	Schizophrenia		Results provide support for an in
7																	
8	cmurphy	22239864		2001-2006	Particulate Matter	Environmental			M/F		distance-weighting estimation	13 u/m3		United States			This study generated estimates c
9	cmurphy	22239864		2001-2006	Ozone	Environmental			M/F		distance-weighting estimation	44 ppb		United States			This study generated estimates c
10																	
11	cmurphy	20978189	Agricultural H	1993-2004	Fonofos	occupational	2,220		M	100% Caucasian	questionnaires			IA, NC, United States	Prostatic Neoplasms		In conclusion, we observed an in
12	cmurphy	20978189	Agricultural H	1993-2004	Coumaphos	occupational	2,220		M	100% Caucasian	questionnaires			IA, NC, United States	Prostatic Neoplasms		In conclusion, we observed an in
13	cmurphy	20978189	Agricultural H	1993-2004	terbufos	occupational	2,220		M	100% Caucasian	questionnaires			IA, NC, United States	Prostatic Neoplasms		In conclusion, we observed an in
14	cmurphy	20978189	Agricultural H	1993-2004	Phorate	occupational	2,220		M	100% Caucasian	questionnaires			IA, NC, United States	Prostatic Neoplasms		In conclusion, we observed an in
15	cmurphy	20978189	Agricultural H	1993-2004	Permethrin	occupational	2,220		M	100% Caucasian	questionnaires			IA, NC, United States	Prostatic Neoplasms		In conclusion, we observed an in
16																	
17	cmurphy	22251442	NHANES III	1988-1994	dimethyl phosphate	Dietary	192		M/F		GC-MS	0.5 u/L	2.07 u/L	United States			Human exposure to organophos
18	cmurphy	22251442	NHANES III	1988-1994	dimethyl phosphate	Dietary	192		M/F		GC-MS	0.5 u/L	13.4 u/L	United States			Human exposure to organophos
19	cmurphy	22251442	NHANES III	1988-1994	dimethyl phosphate	Dietary	192		M/F		GC-MS	0.5 u/L	2.14 u/g creatinine	United States			Human exposure to organophos
20	cmurphy	22251442	NHANES III	1988-1994	dimethyl phosphate	Dietary	192		M/F		GC-MS	0.5 u/L	25.2 u/g creatinine	United States			Human exposure to organophos
21	cmurphy	22251442	NHANES 199	1999-2000	dimethyl phosphate	Dietary	814		M/F		GC-MS	0.58 u/L	0.68 u/L	United States			Human exposure to organophos
22	cmurphy	22251442	NHANES 199	1999-2000	dimethyl phosphate	Dietary	814		M/F		GC-MS	0.58 u/L	9.7 u/L	United States			Human exposure to organophos
23	cmurphy	22251442	NHANES 199	1999-2000	dimethyl phosphate	Dietary	814		M/F		GC-MS	0.58 u/L	0.76 u/g creatinine	United States			Human exposure to organophos
24	cmurphy	22251442	NHANES 199	1999-2000	dimethyl phosphate	Dietary	814		M/F		GC-MS	0.58 u/L	14.6 u/g creatinine	United States			Human exposure to organophos
25	cmurphy	22251442	NHANES 199	2001-2002	dimethyl phosphate	Dietary	1,121		M/F		GC-MS	0.5 u/L	11.5 u/L	United States			Human exposure to organophos

• Status

- ~50 data points captured
- ~3,000 priority articles: 600 curated, 16,000 exposure statements, 300 unique chemicals, 100 diseases

Exposure data

The image shows a screenshot of the Comparative Toxicogenomics Database (CTD) website. At the top left is the CTD logo with the tagline "Giving insight into how chemicals affect our health." To the right of the logo is a search bar with a dropdown menu set to "Chemicals" and a search button. Below the logo is a navigation bar with links for Home, Search, Analyze, Download, and Help. The main content area shows the search results for "bisphenol A". A horizontal menu below the search results includes tabs for Basics, Gene Interactions, Genes, Diseases, Comps, Pathways, GO, Exposure Studies (which is highlighted in yellow), and References. The rest of the page is blank.

bisphenol A

[Basics](#)
[Gene Interactions](#)
[Genes](#)
[Diseases](#)
[Comps](#)
[Pathways](#)
[GO](#)
[References](#)
[Exposure Studies](#)
[Exposure Levels](#)

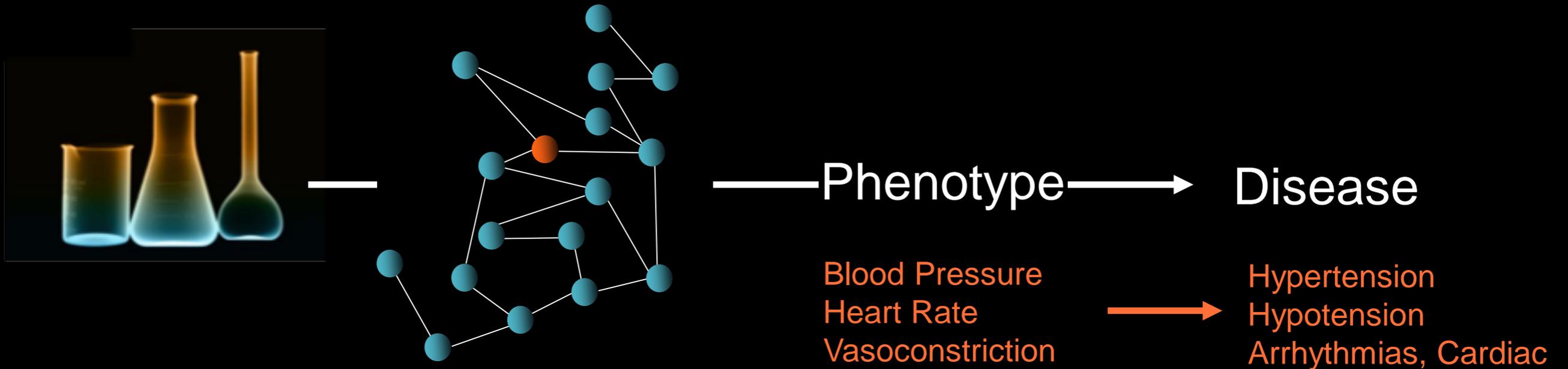
DETAILS

Stressor	Medium	Biomarker	Level	Units	Measurement description	Details
bisphenol A	urine	bisphenol A	1.340	nanograms per milliliter	mean	Nahar, et al. (2012)
Air Pollution	serum	bisphenol A	> 0.700	nanograms per milliliter	median	Nahar, et al. (2012)
Vehicle Emissions	plasma	bisphenol A	< 12.000	nanograms per milliliter	maximum	Nahar, et al. (2012)
bisphenol A	urine	bisphenol A	3.300	micrograms per gram creatinine	median	Madeup et al., (2010)
bisphenol A	urine	bisphenol A, disodium salt A	2.000	micrograms per gram creatinine	median	Madeup et al., (2010)
Estradiol	urine	bisphenol A, disodium salt A	2.600	micrograms per gram creatinine	median	Madeup et al., (2010)
bisphenol A	urine	bisphenol A	0.840	nanograms per milliliter	geometric mean	Madeup et al., (2010)
bisphenol A	urine	TPEN	1.240	parts per million	mean	Sgabjar et al. (2009)
bisphenol A	urine	TPEN	1.000	parts per million	median	Sgabjar et al. (2009)
bisphenol A	urine	TPEN	< 6.200	parts per million	maximum	Sgabjar et al. (2009)
bisphenol A	urine	TPEN	0.790	parts per million	geometric mean	Sgabjar et al. (2009)
bisphenol A	urine	bisphenol A	0.600	nanograms per milliliter	median	Woodruff, et al (2001)
bisphenol A	urine	bisphenol A	12.000	nanograms per milliliter	maximum	Woodruff, et al (2001)
bisphenol A	urine	aluminum-bisphenol A	0.890	nanograms per milliliter	geometric mean	Woodruff, et al (2001)
bisphenol A	urine	bisphenol A	2.830	nanograms per milliliter	mean	Woodruff, et al (2001)
bisphenol A	urine	bisphenol A	2.600	nanograms per milliliter	median	Woodruff, et al (2001)
bisphenol A	urine	bisphenol A	16.100	nanograms per milliliter	maximum	Woodruff, et al (2001)
bisphenol A	urine	bisphenol A	1.960	nanograms per milliliter	geometric mean	You, et al (2007)
bisphenol A	urine	bisphenol A	1.750	nanograms per milliliter	mean	You, et al (2007)
bisphenol A	urine	bisphenol A	1.020	nanograms per milliliter	median	You, et al (2007)
bisphenol A	urine	bisphenol A	10.800	nanograms per milliliter	maximum	You, et al (2007)
bisphenol A	urine	bisphenol A	1.000	nanograms per milliliter	geometric mean	You, et al (2007)
bisphenol A	urine	bisphenol A	2.130	nanograms per milliliter	mean	You, et al (2007)
bisphenol A	urine	bisphenol A	1.020	nanograms per milliliter	median	Cantonwine, et al (2010)
bisphenol A	urine	bisphenol A	10.800	nanograms per milliliter	maximum	Cantonwine, et al (2010)
bisphenol A	urine	bisphenol A			mean	Galloway, et al (2009)
bisphenol A	urine	bisphenol A				Galloway, et al (2009)
bisphenol A	urine	bisphenol A				Galloway, et al (2009)

displays the actual measurements curated from multiple papers, providing a view of the different ranges

data displayed if chemical or its descendant is in the "Stressor" or "Biomarker" column

Phenotype-disease curation



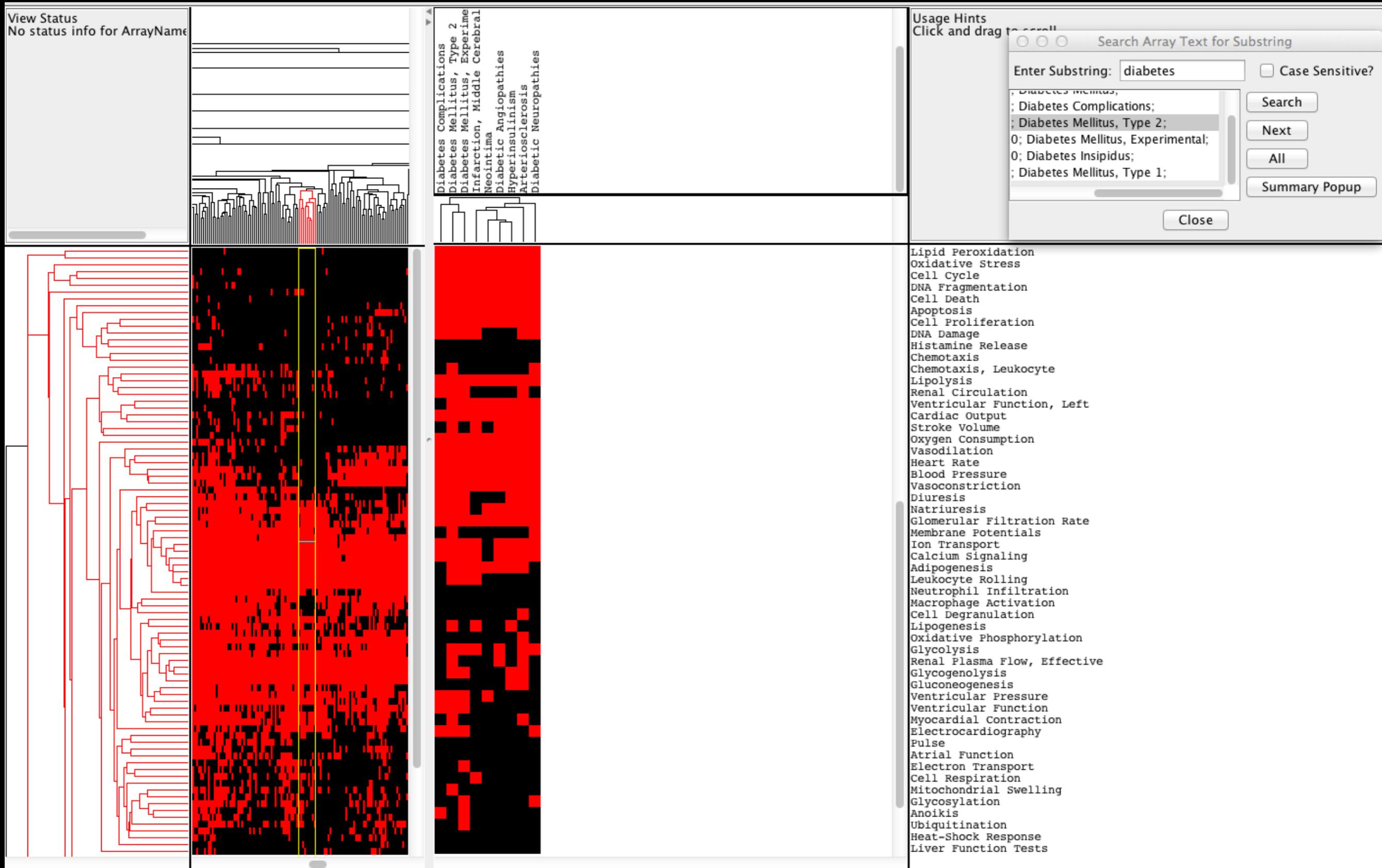
NTP
National Toxicology Program

Free public database

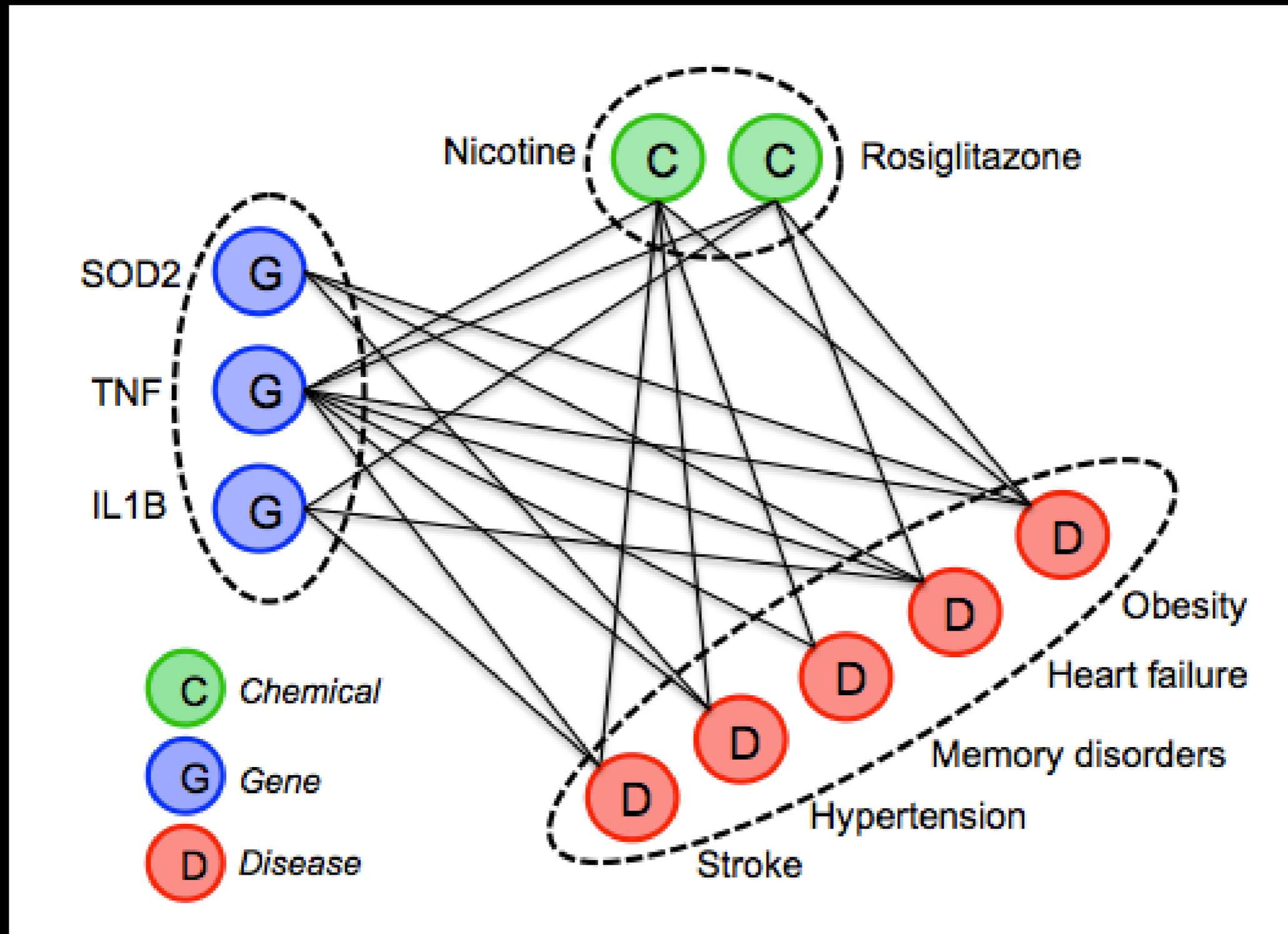
DrugMatrix® and ToxFX®

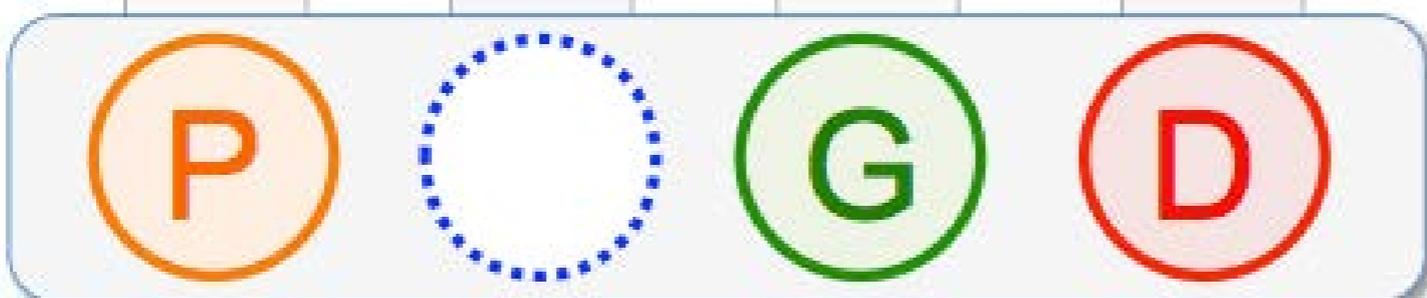
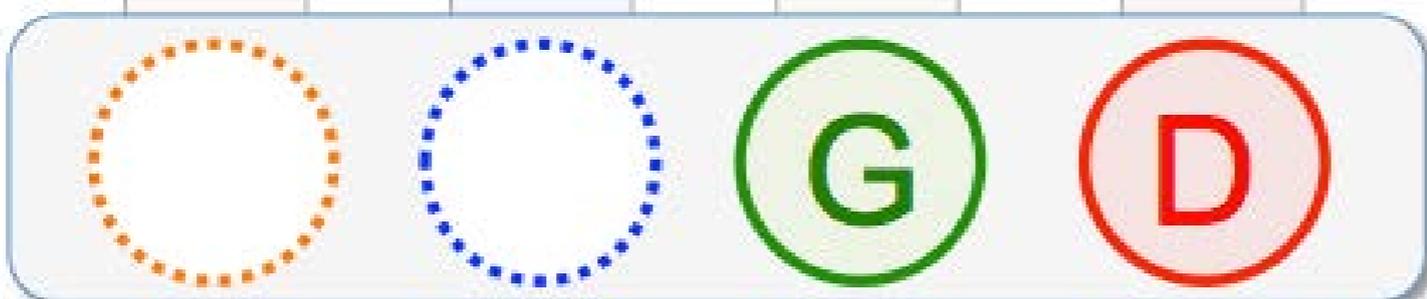
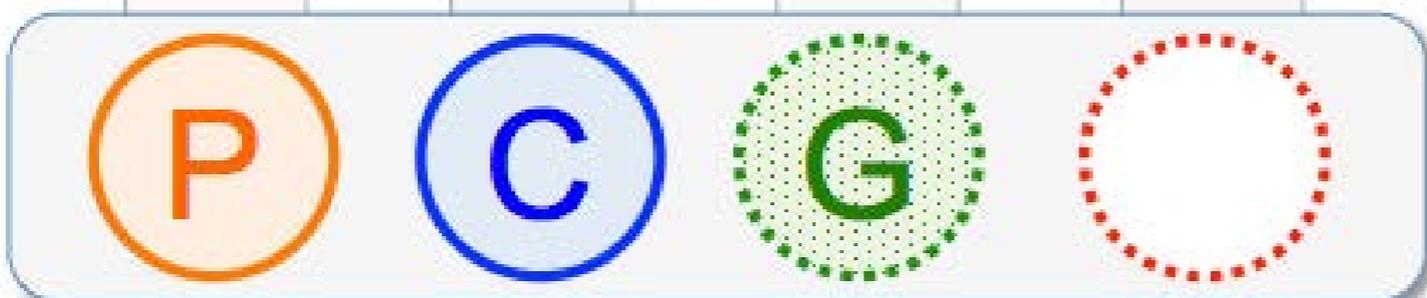
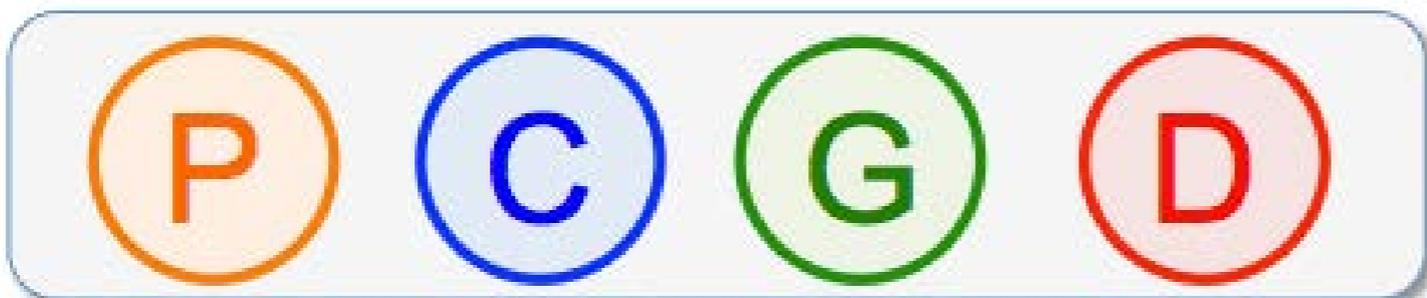
<https://ntp.niehs.nih.gov/drugmatrix>
<https://ntp.niehs.nih.gov/toxfx>

Phenotype-disease analysis



Phenotype-disease analysis





Acknowledgements



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