Toxicology Basics for Molecular Design

Marty Mulvihill
Chris Vulpe
Outline for Day 1

• Introductions
• Compare toxicity of three chemicals
• Introduce Bio-based chemicals project
  – Select chemicals for project
• Chemical and Toxicity Databases
Themes of Green Chemistry: Increase Efficiency

One Barrel (42 Gal.) of Oil Yields:

- Gasoline 43%
- Distillate 21.5%
- Residual 11.5%
- Jet fuel 6.9%
- Feed Stocks 4.7%
- Still gas 3.8%
- Asphalt 3.1%
- Coke 2.6%
- LPG 2.3%
- Kerosene 1.3%
- Lubricants 1.3%
- Miscellaneous 0.67%
Chemical Life Cycle

A Life Cycle Example

1. Extraction
2. Transportation
3. Material Processing
4. Secondary Production
5. Primary Production
6. Disposal
Manufacturing poly(lactic acid) (PLA) from renewable resources
Uses 20-50% fewer fossil fuels than conventional plastics
The synthesis of PLA produces a high yield, does not require organic solvents, and creates no hazardous materials
PLA products can be recycled or composted
PLA resin can be made into fibers and plastics for consumer goods such as clothing and food packaging
Wal-mart is packaging all fresh cut produce in this PLA
Next Generation BioRefining
### Chemicals for Comparison

<table>
<thead>
<tr>
<th>Group</th>
<th>Structure</th>
<th>Name</th>
<th>Structure</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.png" alt="Structure Image" /></td>
<td>p-xylene</td>
<td><img src="image2.png" alt="Structure Image" /></td>
<td>Coumaryl alcohol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therphalic acid</td>
<td></td>
<td>Coumaic acid</td>
</tr>
<tr>
<td>2</td>
<td><img src="image3.png" alt="Structure Image" /></td>
<td>p-xylene</td>
<td><img src="image4.png" alt="Structure Image" /></td>
<td>Coniferyl alcohol</td>
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<tr>
<td></td>
<td></td>
<td>Therphalic Acid</td>
<td></td>
<td>Therphalic Acid</td>
</tr>
<tr>
<td>3</td>
<td><img src="image5.png" alt="Structure Image" /></td>
<td>p-xylene</td>
<td><img src="image6.png" alt="Structure Image" /></td>
<td>Sinapyl alcohol</td>
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<tr>
<td></td>
<td></td>
<td>Hydroxycinnamic acid</td>
<td></td>
<td>Hydroxycinnamic acid</td>
</tr>
<tr>
<td>4</td>
<td><img src="image7.png" alt="Structure Image" /></td>
<td>Adipic acid</td>
<td><img src="image8.png" alt="Structure Image" /></td>
<td>Gluoronic acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Malic Acid</td>
<td></td>
<td>Malic Acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Itaconic acid</td>
<td></td>
<td>Itaconic acid</td>
</tr>
</tbody>
</table>
## More Chemicals for Comparison

<table>
<thead>
<tr>
<th></th>
<th>Chemical</th>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Toluene</td>
<td><img src="image" alt="Toluene Structure" /></td>
<td>Furfuryl alcohol</td>
</tr>
<tr>
<td></td>
<td>Anisole</td>
<td><img src="image" alt="Anisole Structure" /></td>
<td>Propiolactone</td>
</tr>
<tr>
<td>6</td>
<td>Acrylonitrile</td>
<td><img src="image" alt="Acrylonitrile Structure" /></td>
<td>Lactic Acid</td>
</tr>
<tr>
<td></td>
<td>Vinyl Chloride</td>
<td><img src="image" alt="Vinyl Chloride Structure" /></td>
<td>4-hydroxybutanoic acid</td>
</tr>
<tr>
<td>7</td>
<td>BBP</td>
<td><img src="image" alt="BBP Structure" /></td>
<td>DEHP</td>
</tr>
<tr>
<td></td>
<td>DINCH</td>
<td><img src="image" alt="DINCH Structure" /></td>
<td>reflex 100, biobased plastisizer</td>
</tr>
<tr>
<td>8</td>
<td>Terephthalic acid</td>
<td><img src="image" alt="Terephthalic acid Structure" /></td>
<td>2,5 furan dicarboxylic acid-FDCA</td>
</tr>
<tr>
<td></td>
<td>Isosorbide</td>
<td><img src="image" alt="Isosorbide Structure" /></td>
<td></td>
</tr>
</tbody>
</table>


Chemical and Toxicity Database

- Chemical and Chemical property databases
  - Chemist friendly / oriented
  - Interaction/Docking Database
- Toxicology Databases
  - Toxicologist friendly
  - Endpoint focused
  - Meta-databases
- Exposure screening/Assessment
- Metabolism Databases
Chemical and Chemical property databases

- **ChemSpider** - a free chemical structure database providing fast text and structure search access to over 26 million structures from hundreds of data sources

- **PubChem** – Substance, Compound, Bioassay
    - The PubChem substance database contains chemical structures, synonyms, registration IDs, description, related urls, database cross-reference links to PubMed, protein 3D structures, and biological screening results. If the contents of a chemical sample are known, the description includes links to PubChem Compound.
    - The PubChem Compound Database contains validated chemical depiction information that is provided to describe substances in PubChem Substance.
    - The PubChem BioAssay Database contains BioActivity screens of chemical substances described in PubChem Substance. It provides searchable descriptions of each BioAssay, including descriptions of the conditions and readouts specific to a screening protocol.

- **ChEMBL** - is a database of bioactive drug-like small molecules, it contains 2-D structures, calculated properties (e.g. logP, Molecular Weight, Lipinski Parameters, etc.) and abstracted bioactivities (e.g. binding constants, pharmacology and ADMET data)
  - [https://www.ebi.ac.uk/chembl/](https://www.ebi.ac.uk/chembl/)
More Chemical property databases

• eMolecules -eMolecules discovers sources of chemical data by searching the Internet, and receives submissions from data providers such as chemical suppliers and academic research institutions.
  — http://www.emolecules.com/
• ChEBI -Chemical Entities of Biological Interest (ChEBI) -molecular entities focused on ‘small’ chemical compounds.
  — http://www.ebi.ac.uk/chebi/
• NIST Chemistry WebBook -provides thermochemical, thermophysical, and ion energetics data
  — http://webbook.nist.gov/chemistry/
• ChemExper -This database contains chemicals with their physical characteristics
  — http://www.chemexper.com/
• IUPAC-NIST Solubility Database -IUPAC's Solubility Data Series (SDS), begun in the mid-1970s, is an exhaustive compilation and critical evaluation of all the world's published results of experimental determinations of solubility
  — http://srdata.nist.gov/solubility/
• DrugBank - drug data (i.e. chemical, pharmacological and pharmaceutical) data with comprehensive drug target (i.e. sequence, structure, and pathway) information
  — http://www.drugbank.ca/
• ChemBank -small molecules and small-molecule screens
  — http://chembank.broadinstitute.org/
• ChemMine-a compound mining database that facilitates drug and agrochemical discovery and chemical genomics screens
  — http://bioweb.ucr.edu/ChemMineV2/
• Common Chemistry “…a web resource that contains CAS Registry Numbers for approximately 7,900 chemicals of widespread general public interest
  — http://commonchemistry.org/
• Chemical Identifier Resolver -resolver for different chemical structure identifiers and allows one to convert a given structure representation or structure identifier
  — http://cactus.nci.nih.gov/chemical/structure
Chemical Docking/Interaction databases

- ZINC - commercially available compounds for virtual screening
  - [http://zinc.docking.org/](http://zinc.docking.org/)

- BindingDB - public, web-accessible database of measured binding affinities, focusing chiefly on the interactions of protein considered drug-like molecules.
  - [http://www.bindingdb.org/bind/index.jsp](http://www.bindingdb.org/bind/index.jsp)

- PDBBind - provide a collection of experimentally measured binding affinity data (Kd, Ki, and IC50)

- AffinDB - affinity data for protein-ligand complexes of the PDB
  - [http://pc1664.pharmazie.uni-marburg.de/affinity/index.php](http://pc1664.pharmazie.uni-marburg.de/affinity/index.php)

- Dock Blaster - structure based ligand discovery
  - [http://blaster.docking.org/](http://blaster.docking.org/)

- STITCH is a resource to explore known and predicted interactions of chemicals and proteins
  - [http://stitch.embl.de/](http://stitch.embl.de/)

- CoCoCo Database - commercial compound collection for high throughput virtual screening purposes
  - [http://cococo.unibo.it/](http://cococo.unibo.it/)

- STITCH 3 - explore known and predicted interactions of chemicals and proteins.
  - [http://stitch.embl.de/](http://stitch.embl.de/)
Toxicity Meta – Databases

- **Toxnet – 14 databases**
- eChem Portal – OECD 17 databases
- ESIS: European chemical Substances Information System - aggregates data from a number of other European databases
- ACToR - Aggregated Computational Toxicology Resource - publicly available information on chemical identity, structure, physical-chemical properties, in vitro assay results, and in vivo toxicology data
  - [http://actor.epa.gov/actor/faces/ACToRHome.jsp](http://actor.epa.gov/actor/faces/ACToRHome.jsp)
- EPA Substance Registry Service - data on regulated substances
  - [http://iaspub.epa.gov/sor_internet/registry/substreg/home/overview/home.do](http://iaspub.epa.gov/sor_internet/registry/substreg/home/overview/home.do)
Toxnet Databases

- ChemIDplus - Dictionary of over 370,000 chemicals (names, synonyms, and structures).Includes links to NLM and other databases and resources.
- Hazardous Substances Data Bank (HSDB) - Comprehensive, peer-reviewed toxicology data for about 5,000 chemicals.
- Toxicology Literature Online (TOXLINE) - References from toxicology literature.
- Chemical Carcinogenesis Research Information System (CCRIS) - Carcinogenicity and mutagenicity test results for over 8,000 chemicals.
- Developmental and Reproductive Toxicology Database (DART) - References to developmental and reproductive toxicology literature.
- Genetic Toxicology Data Bank (GENE-TOX) - Peer-reviewed genetic toxicology test data for over 3,000 chemicals resulting from expert peer review of the open scientific literature.
- Integrated Risk Information System (IRIS) - Hazard identification and dose-response assessments for over 500 chemicals.
- International Toxicity Estimates for Risk (ITER) - Risk information for over 600 chemicals from authoritative groups worldwide.
- LactMed - a database of drugs and other chemicals to which breastfeeding mothers may be exposed.
- Toxics Release Inventory (TRI) - Annual environmental releases of over 600 toxic chemicals by U.S. facilities. About the Environmental Protection Agency (EPA) Toxics Release Inventory (TRI) Program.
- TOXMAP—Geographic Information System that uses maps of the United States to help users visually explore TRI data.
- HazMap - Information on Hazardous Chemicals and Occupational Diseases.
- Household Products Database – Health and Safety on Household Products.
- Carcinogenic Potency Database - standardized analyses of the results of 6540 chronic, long-term animal cancer tests that have been conducted since the 1950's and reported in the general published literature or by the National Cancer Institute and the National Toxicology Program.
- Comparative Toxicogenomics Database (CTD)™ - elucidates molecular mechanisms by which environmental chemicals affect human disease.
eChem Portal

- **ACToR** - U.S. EPA Aggregated Computational Toxicology Resource
- **AGRITOX** – Pesticide toxicity data
- **CCR** - Canadian Categorization Results
- **CESAR** - Canada’s Existing Substances Assessment Repository
- **CHRIP** - Information on Biodegradation and Bioconcentration of the Existing Chemical Substances in the Chemical Risk information platform (CHRIP)
- **Combined Exposures** - Collection of Case Studies on Risk Assessments of Combined Exposures to Multiple Chemicals
- **ECHA CHEM** - European Chemicals Agency’s Dissemination portal with information on chemical substances registered under REACH.
- **EnviChem** - Data Bank of Environmental Properties of Chemicals
- **ESIS** - European Chemical Substances Information System (ESIS)
- **GHS-J** - The Result of the GHS Classification by the Japanese Government
- **HPVIS** - High Production Volume Information System (HPVIS)
- **HSDB** - Hazardous Substance Data Bank
- **HSNO CCID** - New Zealand Hazardous Substances and New Organisms Chemical Classification Information Database
- **INCHEM** - Chemical Safety Information from Intergovernmental Organizations – INCHEM
- **J-CHECK** - Japan CHEmicals Collaborative Knowledge database
- **JECDB** - Japan Existing Chemical Data Base
- **NICNAS Other** - Australian National Industrial Chemicals Notification and Assessment Scheme assessments of existing chemicals other than Priority Existing Chemical assessments
- **NICNAS PEC** - Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS) Priority Existing Chemical Assessment Reports
- **OECD HPV** - Organisation for Economic Cooperation and Development (OECD) Existing Chemicals Database
- **OECD SIDS IUCLID** - OECD Existing Chemicals Screening Information Data Sets (SIDS) Database
- **SIDS UNEP** - OECD Initial Assessment Reports for HPV Chemicals including Screening Information Data Sets (SIDS) as maintained by United Nations Environment Programme (UNEP) Chemicals
- **UK CCRMP Outputs** - UK Coordinated Chemicals Risk Management Programme Publications
- **US EPA IRIS** - United States Environmental Protection Agency Integrated Risk Information System
- **US EPA SRS** - United States Environmental Protection Agency Substance Registry Services
ESIS : European chemical Substances Information System

http://esis.jrc.ec.europa.eu/

- EINECS (European Inventory of Existing Commercial chemical Substances)
- ELINCS (European List of Notified Chemical Substances)
- NLP (No-Longer Polymers).
- BPD (Biocidal Products Directive)
- PBT (Persistent, Bioaccumulative, and Toxic)
- vPvB (very Persistent and very Bioaccumulative).
- CLP/GHS (Classification, Labelling and Packaging of substances and mixtures)
- HPVCs (High Production Volume Chemicals) and LPVCs (Low Production Volume Chemicals).
- IUCLID Chemical Data Sheets, OECD-IUCLID Export Files, EUSES Export Files.
More databases

- **Scoreard** - [http://scorecard.goodguide.com/](http://scorecard.goodguide.com/)
- P450 Drug Interaction Table - [http://medicine.iupui.edu/clinpharm/DDIs/table.aspx](http://medicine.iupui.edu/clinpharm/DDIs/table.aspx)
- Psychoactive Drug Screening Program Database - [http://pdsp.med.unc.edu/indexR.html](http://pdsp.med.unc.edu/indexR.html)
- **BindingDB** I measured binding affinities, focusing chiefly on the interactions of protein considered to be drug-targets with small, drug-like molecules. – [http://www.bindingdb.org/bind/index.jsp](http://www.bindingdb.org/bind/index.jsp)
- PDBbind database is designed to provide a collection of experimentally measured binding affinity data (*Kd, Ki, and IC50*) exclusively for the protein-ligand complexes available in the Protein Data Bank (PDB - [http://sw16.im.med.umich.edu/databases/pdbbind/index.jsp](http://sw16.im.med.umich.edu/databases/pdbbind/index.jsp))
- **AffinDB** “… affinity data for protein-ligand complexes of the PDB - [http://pc1664.pharmazie.uni-marburg.de/affinity/index.php](http://pc1664.pharmazie.uni-marburg.de/affinity/index.php)
- OpenTox - an interoperable predictive toxicology framework which may be used as an enabling platform for the creation of predictive toxicology applications - [http://opentox.org/](http://opentox.org/)
- OECD Screening Information Data Sets (SIDS) - [http://www.inchem.org/pages/sids.html](http://www.inchem.org/pages/sids.html)
- Fraunhofer ITEM Repeated dose toxicity - [http://www.fraunhofer-repdose.de](http://www.fraunhofer-repdose.de)
- ISSSCAN (Chemical carcinogens) - [http://www.iss.it/ampp/dati/cont.php?id=233&lang=1&tipo=7](http://www.iss.it/ampp/dati/cont.php?id=233&lang=1&tipo=7)
Specific chemicals, mixtures, and products
Unknown chemicals
Special toxic effects of chemicals in humans and/or animals
Search Terms—You may enter any combination of words, chemical names, and numbers, including Chemical Abstracts Service (CAS) registry numbers. When searching for terms other than chemicals, the system automatically searches for singular and plural forms of the term(s) entered.

Your results will be displayed as links to the databases in which your search term(s) were found—and the number of records in each—under the headings: References from the Biomedical Literature (TOXLINE and DART) and Chemical, Toxicological, and Environmental Health (all others).
Toxnet - Searching

- Synonym searching—By default the system will search for the exact name, synonyms, and CAS number as derived from ChemIDplus. Select “No” to search only for the exact chemical term or CAS Registry Number entered. In LactMed, the CAS number refers to the parent compound (i.e., not the salt form).
- Truncation—The asterisk (*) is the right-handed truncation symbol for any number of characters.
- Phrase searching—Search phrases with quotation marks.
- Boolean searching—Use the logical operators “AND,” “OR,” and “NOT” to limit a search of two or more terms to specific criteria. In searches with combinations of these operators, “AND” takes precedence, followed by “NOT” and then “OR.” This default precedence may be overridden with the use of parentheses, which may also be nested (i.e., parentheses within parentheses).
  - Examples: Pulmonary AND edema—retrieves all records with the two words appearing together
  - Liver OR kidney—retrieves all records containing either of these words (or both of them)
  - Carcinoma NOT squamous—retrieves records from which one or more terms have been excluded
- Browse the Index—This feature provides a scannable index of all terms beginning with the search term you entered and the number of records for each term.
  - In the Toxicology Data databases, selectable items indexed are All Words, CAS Registry Number, and Chemical Name.
  - In the Toxicology Literature databases, selectable items indexed are All Words, MeSH Headings/Keywords, Authors, and CAS Registry Number.
Toxnet - Searching

Search Results buttons—Buttons on the left of the search results screen allow you to:

- **Save Checked Items**—save items in a set for displaying, sorting, and downloading
- **Sort**—sort the entire search results or items saved in a set
- **Download**—download the entire search results or items save in a set in brief, full, abstract, or tagged format
- **Modify Search**—make changes to the most recent search
- **Basic Search**—conduct a new search in the same database
- **Browse Index**—browse all words, CAS Registry Number, chemical name, and in bibliographic databases MeSH headings/keywords and authors
- **Go to the Help file for that database**
- **Go to TOXNET Home**
Navigation buttons—Buttons at the top of the record screen allow you to:

- Go to the **Next Item** in the search results
- Go back to the **Search Results** screen
- Perform a new **Basic Search** in the same database
- View **Details** of the search
- Display links to **Other Files** (NLIM databases) containing information on the substance
- **Modify [your] Search**
- **Download** the record or portions of the record
- Perform a new search in the same database with **Limits** applied
- **Browse [the] Index**
- Go to the **Help file** for that database
- Go to **TOXNET Home**
ChemIDplus

ChemIDplus Lite
- simple searching on name or registry number
- basic information about a chemical
- links to other resources
- displays structures, but does not allow drawing or searching.

Link to ChemIDplus Advanced
- advanced searching on any combination of name, registry number, molecular formula, classification code, locator code, toxicity, physical property, structure, or molecular weight.
- draw their own structures and perform similarity and substructure searches

toxnet.nlm.nih.gov
**Record for Diazepam (ChemIDplus Lite)**

**Basic Information**

- **Full Record**
- **Names & Synonyms**
- **Formulas**
- **Coordinates**
- **Registry Numbers**
- **Notes**
- **Toxicity**
- **Physical Properties**

**File Locator**

- CORDIS
- Drug Files.gov
- DAHT
- DaltMed
- DalPortal
- EINECS
- EMCS
- GENETOX
- HDBE
- LeadMed
- Mesh
- MESH Heading
- MedlinePlus
- MedlinePlusDrugInfo
- NIOSH
- PCCD
- PubChem
- PubMed
- PubMed AIDS
- PubMed Cancer
- PubMed Toxicology
- RTECS
- TOLINE

**Internet Locator**

- CANEC
- CPDB
- CTD
- CHEBI
- ChEBIDrugPortal
- DrugBank
- EPA Endocrine
- EPA-ATSDR
- EPA-NOTES
- NCI-DRUG
- NLM ChemDB
- NIST WebBook
- NITSRS
- NTP DRS
- NTP Databank
- NYHC Sub. Fact Sheets
- NTP Database Search
- TOSCA
- TOXNET
- TOXLINE

**Superlist Locator**

- California Proposition 65 List
- DEA
- DSL
- IARC
- TSCA
- TSCA
tu
- UCIT
- EPA Chemical Substances List
- EPA Chemical Substances Inventory

**Search Navigation**

- Advanced ChemIDplus Search
- Main Query Page

**Link resources with biomedical data of interest for the chemical.**

**Link to and scientific lists that contain information about the chemical.**

**Link to a set of NLM associated databases.**

**Other names used for chemical.**

**Links to PubMed articles.**
Enter basic search term

Qualify a toxicity search

Select and qualify a physical property

Qualify a search with specific "locator" resources

Click in box to draw structures

Select type of structure search

Search by molecular weight or range
HSDB (Hazardous Substances Data Bank) peer-reviewed by the Scientific Review Panel

toxnet.nlm.nih.gov
Browse the Index

Listed in order of relevancy

Browse the Index list of index terms related to the search term entered and the number of records containing that term.

Primary Record

Other Chemical Records

Results Screen Listed in order of relevancy
1. Navigation buttons at the top of the screen allow you to link to Other Files (NLM databases), modify your search (Modify Search), Download, return to the Basic Search screen, and more.

2. A Table of Contents in the left frame allows you to choose categories and fields for display.

3. Chemical data is shown in the right frame. Your search term(s) appear in red.
Toxline

• Standard biomedical/toxicology journal literature
  • PubMed/MEDLINE
• Special journal and other research literature
  • Developmental and Reproductive Toxicology (DART)
  • International Labour Office (CIS)
• Technical reports and research projects
  • Federal Research in Progress (FEDRIP)
  • Toxic Substances Control Act of Test Submissions (TSCATS)
  • Toxicology Document and Data Depository (NTIS)
  • Toxicology Research Projects (CRISP)

Meeting Abstracts
• Archival Collection (no longer being updated)
  • Aneuploidy (ANEUPL)
  • Environmental Mutagen Information Center File (EMIC)
  • Environmental Teratology Information Center File (ETIC)
  • Epidemiology Information System (EPIDEM)
  • Hazardous Materials Technical Center (HMTC)
  • Health Aspects of Pesticides Abstract Bulletin (HAPAB)
  • International Pharmaceutical Abstracts (IPA)
  • NIOSHTIC (NIOSH)
  • Pesticides Abstracts (PESTAB)
  • Poisonous Plants Bibliography (PPBIB)
  • Swedish National Chemicals Inspectorate (RISKLINE)
  • Toxicological Aspects of Environmental Health (BIOSIS)
Related Records—search for articles similar in subject matter to the one displayed. The search used a formula based on data in the displayed record.

Search Results—return to the complete list of results.

TOXLINE Fact Sheet

Importing Citations into Reference Manager
sis.nlm.nih.gov/enviro/captivate/toxlinespecialimports.html
1. Navigation buttons at the top of the screen allow you to link to Other Files (NLM databases), Modify Search, Download, return to the Basic Search screen, and more.

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DART – Developmental and Reproductive Toxicology

DART Fact Sheet
nlm.nih.gov/pubs/factsheets/dartfs.html
GENOTOX Fact Sheet
.nlm.nih.gov/pubs/factsheets/genetxfs.html

Primary Record

Other Chemical Records
1. Navigation buttons at the top of the screen allow you to link to Other Files (NLM databases), Modify Search, Download, return to the Basic Search screen, and more.

2. A Table of Contents in the left frame allows you to choose categories and fields for display.

3. Chemical Data is shown in the right frame. Your search term(s) appear in red.
Integrated Risk Information System (IRIS)

- 500 chemicals - EPA human health data
**Integrated Risk Information System (IRIS) Advanced Search Results**

Found 103 IRIS Summary/Toxicological Review result(s) that match your Keyword Search criteria: *benzene*

<table>
<thead>
<tr>
<th>Substance Name</th>
<th>CASRN</th>
<th>QuickView</th>
<th>IRIS Summary</th>
<th>Tox Review/Support Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /> (PDF, 180 pp, 1.59 MB) Support Document</td>
</tr>
</tbody>
</table>

Displaying 1 through 15 out of 102 Additional Result(s):

<table>
<thead>
<tr>
<th>Substance Name</th>
<th>CASRN</th>
<th>QuickView</th>
<th>IRIS Summary</th>
<th>Tox Review/Support Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetophenone</td>
<td>98-86-2</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /></td>
</tr>
<tr>
<td>Anthracene</td>
<td>120-12-7</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /></td>
</tr>
<tr>
<td>Azobenzene</td>
<td>103-33-3</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /></td>
</tr>
<tr>
<td>Benzaldehyde</td>
<td>100-52-7</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /></td>
</tr>
<tr>
<td>Benzidine</td>
<td>92-87-5</td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Icon" /></td>
<td><img src="https://example.com" alt="Download" /></td>
</tr>
<tr>
<td>Benzotrichloride</td>
<td>98-07-7</td>
<td><img src="https://example.com" alt="Icon" /></td>
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<td>Bromobenzene</td>
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<td><img src="https://example.com" alt="Download" /> (PDF, 123 pp, 786 K) Support Document</td>
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</table>
ITER (International Toxicity Estimates for Risk)

Toxicology Excellence for Risk Assessment

- Agency for Toxic Substances & Disease Registry (ATSDR)
- Health Canada
- U.S. Environmental Protection Agency (EPA)
- International Agency for Research on Cancer (IARC)
- NSF International (National Sanitation Foundation)
- National Institute of Public Health & the Environmental (RIVM), The Netherlands