

science in ACTION

INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE



Computational Toxicology Research

Fast, Automated Screening for Risk-Based Chemical Prioritization

Under different federal statutes, EPA makes a broad range of decisions to protect public health and the environment from unintended consequences of using chemicals. Decisions about chemicals are also made by other Federal Agencies, State Environmental and Health Agencies, International Governmental Agencies and Industry. As examples, there are specific federal laws for pesticides, drinking water contaminants, commercial and industrial chemicals, chemicals found on contaminated sites and endocrine disrupting chemicals.

Through its computational toxicology research, the U.S. Environmental Protection Agency (EPA) is developing ground-breaking approaches to change how chemicals are evaluated for potential health effects. Computational toxicology research integrates advances in biology, biotechnology, chemistry, and computer science to identify important biological processes that may be disrupted by the chemicals and trace those biological disruptions to a related dose and human exposure. The combined information helps prioritize chemicals based on potential human health risks. Using this research, thousands of chemicals can be evaluated for potential risk at a small cost in a very short amount of time.

CompTox Tools and Resources

CompTox Chemicals Dashboard

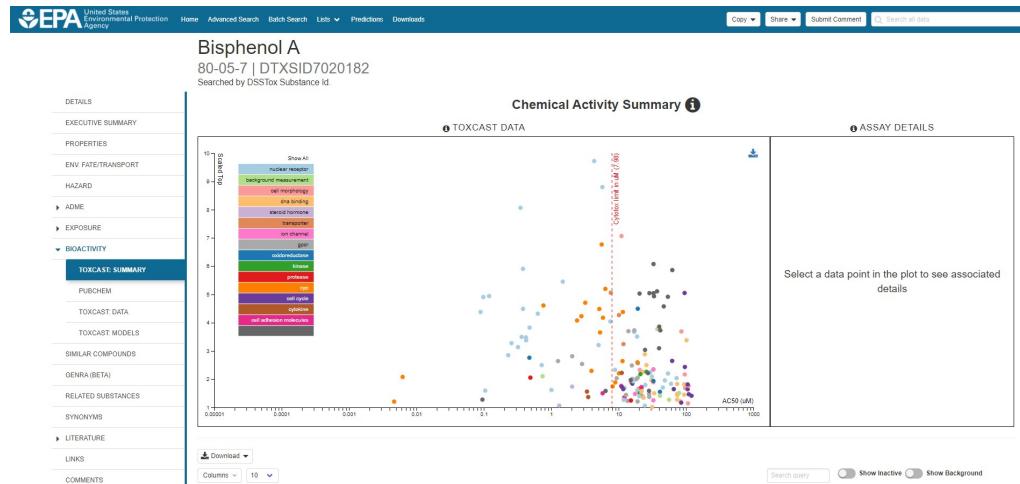
The CompTox Chemicals Dashboard is a one-stop-shop for chemistry, toxicity and exposure information for almost 900,000 chemicals. Data and models within the Dashboard also help to identify chemicals of most need of further testing which can lead to the reduction of animals used in chemical testing. The Dashboard can be searched by chemical identifiers (e.g. Name and CASRN), consumer product use categories, and assays/genes associated with high-throughput screening data. The Dashboard also contains chemical lists, assay lists and downloads for all the data.

These data are compiled from sources including the EPA's computational toxicology research databases, and public domain databases such as the National Center for Biotechnology Information's PubChem database and EPA's ECOTOX Knowledgebase.

ExpoCast (Exposure Forecaster)

EPA's ExpoCast effort is developing rapid, automated chemical exposure predictions for thousands of chemicals based on manufacture and use information. EPA scientists developed ExpoCast to estimate exposures for almost 8,000 chemicals using production volume, environmental

fate and transport models, and a simple indicator of consumer product use. The ExpoCast approach can be used to make high-throughput exposure predictions for human exposures to chemicals and to understand where additional information is required to improve these estimates. Since indoor and consumer product use are large determinants of exposure ExpoCast estimates are improved as this information is added.



Computational Toxicology Research Program

Indoor and consumer use information comes from the EPA Chemical and Products Database (CPDat), a database that maps more than 49,000 chemicals to a set of terms categorizing their use or function in 16,000 consumer products (e.g. shampoo, soap) types based on what chemicals they contain. This information comes from a wide variety of sources and is available online through the CompTox Chemicals Dashboard.

EPA researchers are also developing more precise methods for estimating chemical concentrations in humans following exposure. EPA scientists developed a method to make its high-throughput results more applicable to humans by replacing the traditional constant exposure rate with more realistic human exposure pathways.

EPA researchers developed four toxicokinetic models within a R software package called high-throughput toxicokinetics to estimate chemical concentrations in humans. The package can currently use human high-throughput screening data to make predictions for 391 chemicals in humans, rats, mice, dogs, and rabbits, including 76 pharmaceuticals and 282 ToxCast chemicals.

ToxCast™

ToxCast is a multiyear, multimillion dollar effort that uses advanced science tools to help understand how human biology is impacted by exposure to chemicals and to determine which exposures may lead to adverse health effects. ToxCast uses automated chemical screening technologies, called "high-throughput screening assays", to expose living cells or isolated proteins

ToxCast & Tox21 Number of Chemicals and Assays

Set	# of Chemicals	# of Assays	Year Released	Where to Access Data
ToxCast Data Available	~4,700	~1,000		
Phase I	~300		2010	CompTox Chemicals Dashboard & Download
Phase II	~750		2015	CompTox Chemicals Dashboard & Download
Phase III	~4,500	Subset of the ToxCast assays	2018	CompTox Chemicals Dashboard & Download
Endocrine Related	~800	~30	2015	CompTox Chemicals Dashboard & Download
Tox21	~8,900	~100	2015	CompTox Chemicals Dashboard, PubChem & Download

to chemicals. The cells or proteins are then screened for changes in biological activity that may suggest potential toxic effects. ToxCast has generated data on over 4,500 chemicals evaluated in over 700 high-throughput screening assay endpoints.

The strategies being developed to guide the implementation of the Toxic Substance Control Act's pre-prioritization and the use of new approach methods for chemical testing describe the use of ToxCast data. It has also been used to develop and evaluate new methods to test chemicals for potential health effects such as endocrine disruption.

ToxCast chemical screening data is publicly available through the CompTox Chemicals Dashboard and through the CompTox downloadable data website.

ToxRefDB (Toxicity Reference Animal Data)

ToxRefDB contains approximately 30 years and \$2 billion worth of animal studies. ToxRefDB allows scientists and the interested public to search and download thousands of animal toxicity testing results for hundreds of chemicals that were previously found only in paper documents. Currently, there are 474 chemicals in ToxRefDB, primarily the data rich pesticide active ingredients, but the number will continue to expand.

Virtual Tissues

Virtual Tissue Models map existing chemical research to dynamic computer simulated models of biological tissues. These computer models can virtually simulate how chemicals interact with important biological processes or signaling pathways and how those interactions lead to potential adverse effects in human tissues. The computer models are constructed using an adverse outcome pathway (AOP) approach. The research is currently focusing on developing advanced computer simulated models of biological processes critical for normal development and function. An example includes the Virtual Embryo (v-Embryo™) model for predicting a chemical's potential to lead to developmental toxicity due to disruption of blood vessel development in embryos. Ultimately, the suite of v-Embryo models will help predict what chemical-biological interactions might lead to developmental toxicity and birth defects.

Collaboration Opportunities

EPA's computational toxicology research efforts actively engage a wide-range of partners including EPA regions and program offices, industry, academia, trade associations, other federal agencies, state and local government agencies and non-governmental organizations to help make this new chemical information more understandable and useable. EPA's computational toxicology stakeholder outreach includes workshops, webinars and training for partners as well as opportunities for stakeholders to provide suggestions for enhancing the research activities. Monthly Communities of Practice webinars are held and anyone with an interest in computational toxicology research can participate. EPA's computational toxicology researchers also partner with hundreds of outside organizations to collaborate on research. EPA provides funding to academic centers working on various aspects of computational toxicology through EPA's Science to Achieve Results (STAR) program.

More information, go to:
www.epa.gov/comptox

National Center for Computational Toxicology

CompTox Chemicals Dashboard <https://comptox.epa.gov/dashboard>

Chemical Safety for the 21st Century Act <https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act>

Downloadable CompTox Data <https://www.epa.gov/chemical-research/downloadable-computational-toxicology-data>

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