Plastics, Chemicals, and Cancer: The Role of the Global Plastics Treaty in Preventing Breast Cancer

Dr. Jennifer Kay and Rashmi Shakti

Silent Spring Institute

CHE-Alaska Webinar

February 27, 2025

SILENT SPRING INSTITUTE

Researching the Environment and Women's Health

Silent Spring Institute

- Massachusetts Breast Cancer Coalition founded Silent Spring Institute in 1994
- Our goal: prevent cancers by reducing people's exposure to harmful chemicals where they live, work, and play

"A lab of our own"

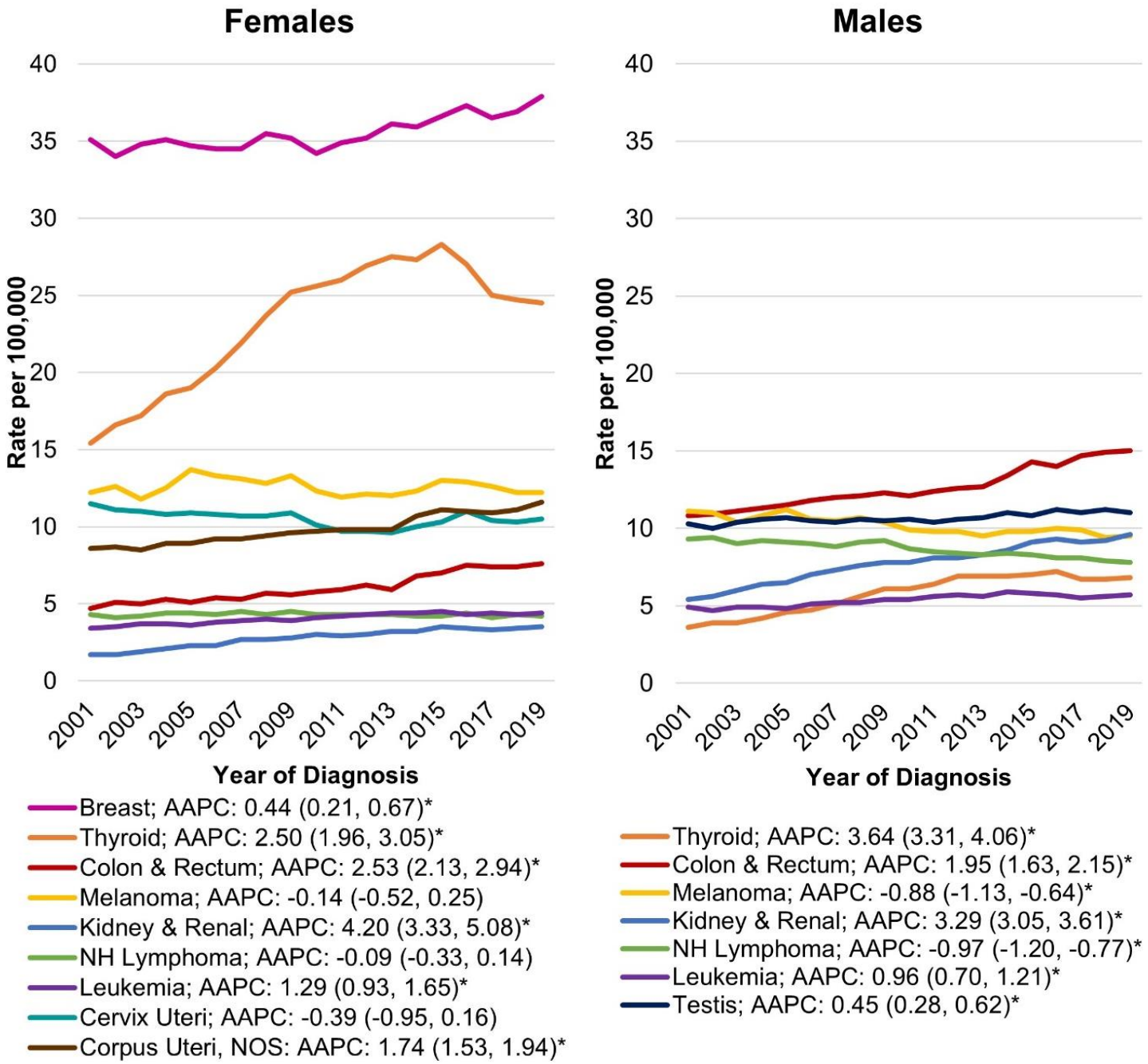
Who we are

Silent Spring Institute is a mission-driven scientific research organization dedicated to uncovering the environmental causes of breast cancer.

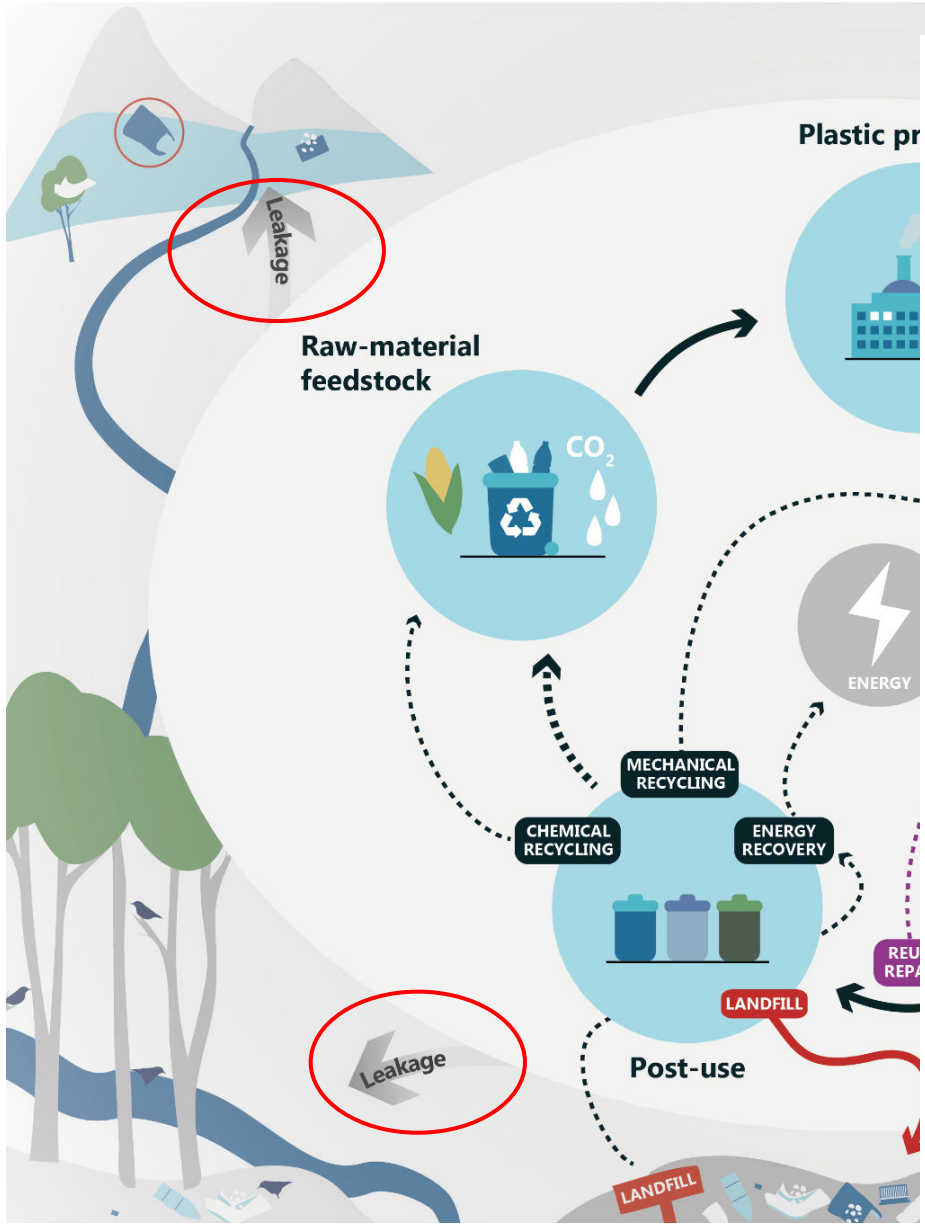
Cancer Incidence 2001-2019 Adults age 18 - <50

- Rising rates of breast cancer cannot be explained by genetics
- Our changing landscape of chemical exposures may play a role

Kehm R and Terry MB Oncologist 2024



Lifecycle of Plastics



Climate

The Washington Post

Our brains are filling with more and more microplastics, study shows

A new study shows that microplastics have crossed the blood-brain barrier — and that their concentrations are rising.

SCIENCE

The Atlantic

What Happens When a Plastic City Burns

Most modern couches are basically blocks of gasoline.

By Zoë Schlanger

ScienceDirect

From e-waste to living space: Flame retardants contaminating household items add to concern about plastic recycling

Megan Liu [a], Sicco H. Brandsma [b], Erika Schreder [a]

Figure: https://debrisfreeoceans.org/wp-content/uploads/2020/01/life-cycle-500x500.png

UN Plastics Conference

Session 1: Uruguay	Session 2: Paris	Session 3: Nairobi	Session 4: Ottawa	Session 5: Busan
28 November 2022 – 2 December 2022	29 May 2023 – 2 June 2023	13 November 2023 – 19 November 2023	23 April 2024 – 29 April 2024	25 November 2024 – 1 December 2024

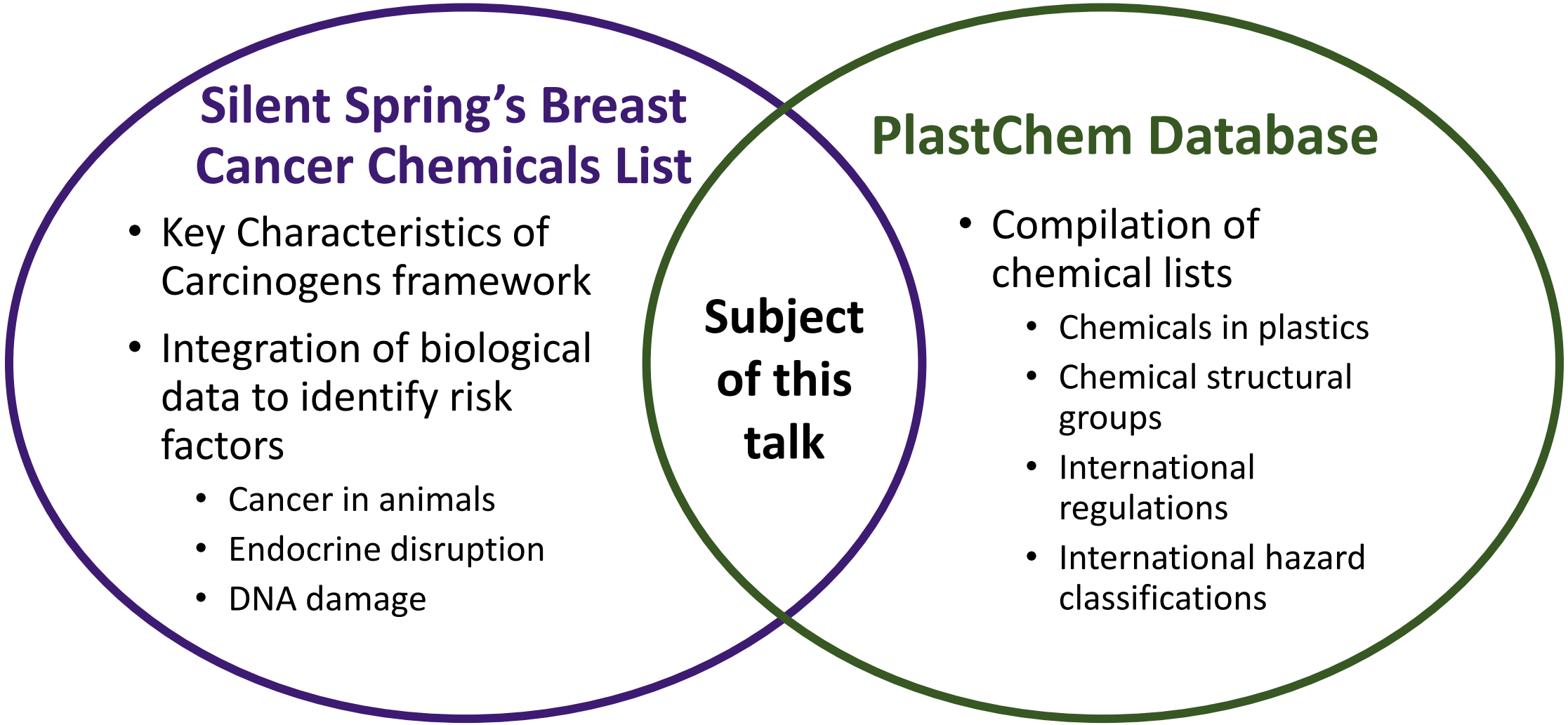
Grist

The US no longer supports capping plastic production in UN treaty

Environmental advocates understand the announcement as a reversal, calling it "absolutely devastating."

"Every day of delay is a day against humanity. Postponing negotiations does not postpone the crisis." -- Juan Carlos Monterrey Gomez (Panama delegation head)

Potential Breast Carcinogens in Plastics



ehp Environmental Health Perspectives

Research Article | 10 January 2024

Application of the Key Characteristics Framework to Identify Potential Breast Carcinogens Using Publicly Available *in Vivo*, *in Vitro*, and *in Silico* Data

This article accompanies **INVITED PERSPECTIVE: NEW MOTIVATIONS AND FUTURE DIRECTIONS FOR INVESTIGATING ENVIRONMENTAL RISK FACTORS FOR BREAST CANCER.**

Authors: Jennifer E. Kay, Julia Green Brody, Megan Schwarzman,, and Ruthann A. Rudel | AUTHORS INFO & AFFILIATIONS

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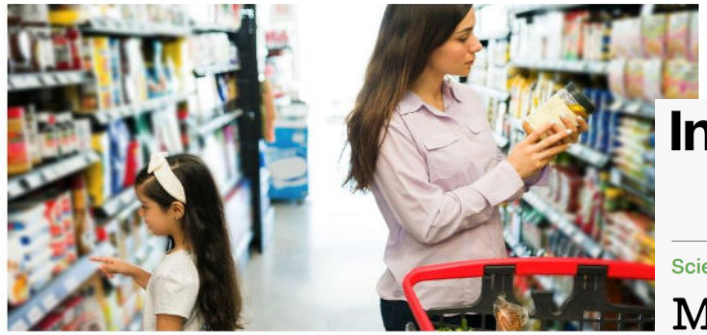

Credit: Unsplash+

More than 900 common chemicals linked to breast cancer risk: Study

Many of these chemicals are commonly found in food, hair products and skincare products.

by Kristina Marusic • January 10, 2024 • 3 min read

The Washington Post

Democracy Dies in Darkness

Over 900 chemicals linked to greater breast cancer risk by researchers

90 percent of the chemicals are found in commonly used consumer products, researchers say

By Linda Searing

Inside Climate News

Science

More Than 900 Widely Used Chemicals May Increase Breast Cancer Risk

Ninety percent of the chemicals identified as potential breast carcinogens in a new study are found in everyday products in homes and workplaces.

The ASCO Post

A New Approach to Identifying Consumer Products That Contain Cancer-Causing Chemicals

Breast Cancer Etiology

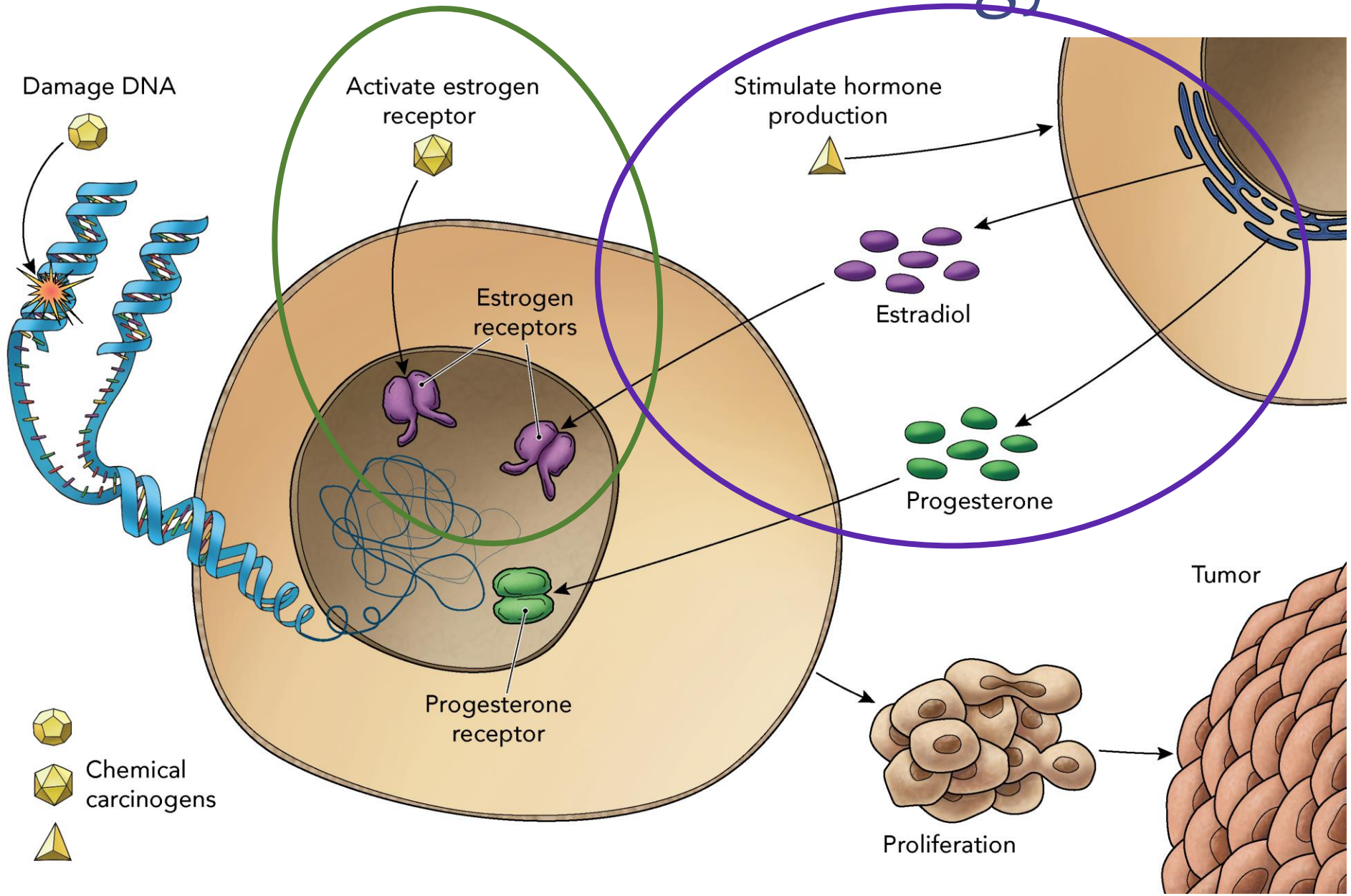

Image credit Jeff Dixon for Silent Spring

Breast Cancer-Relevant Exposures

920 chemicals, Ionizing radiation

Type of Evidence

Rodent Mammary Carcinogens (MCs)

278 chemicals, Ionizing radiation

Databases from IARC, EPA,
National Toxicology Program, and others

Disease outcome
In animals

Estrogen/Progesterone Increasers

346 E2-up, 307 P4-up, 515 total

EPA ToxCast chemical screening

Estrogen Receptor (ER) Activators

267 total

EPA ToxCast chemical screening

Molecular activity
In cells

DNA Damage (Genotoxicity)

Databases from US and international agencies

***Chemicals in plastics**

Molecular activity
Animals and cells

Kay et al., EHP 2024, DOI 10.1289/EHP13233

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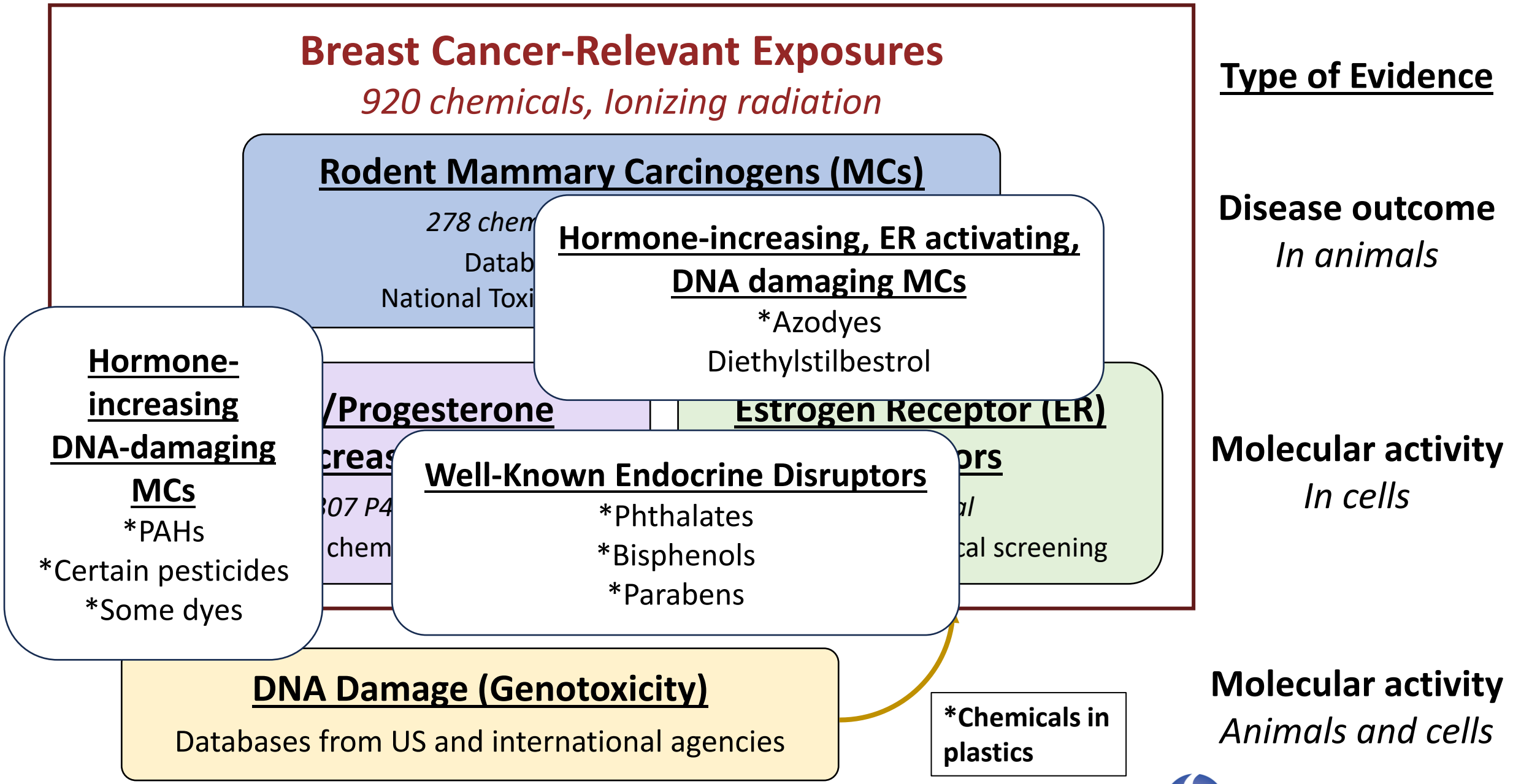

Kay et al., EHP 2024, DOI 10.1289/EHP13233

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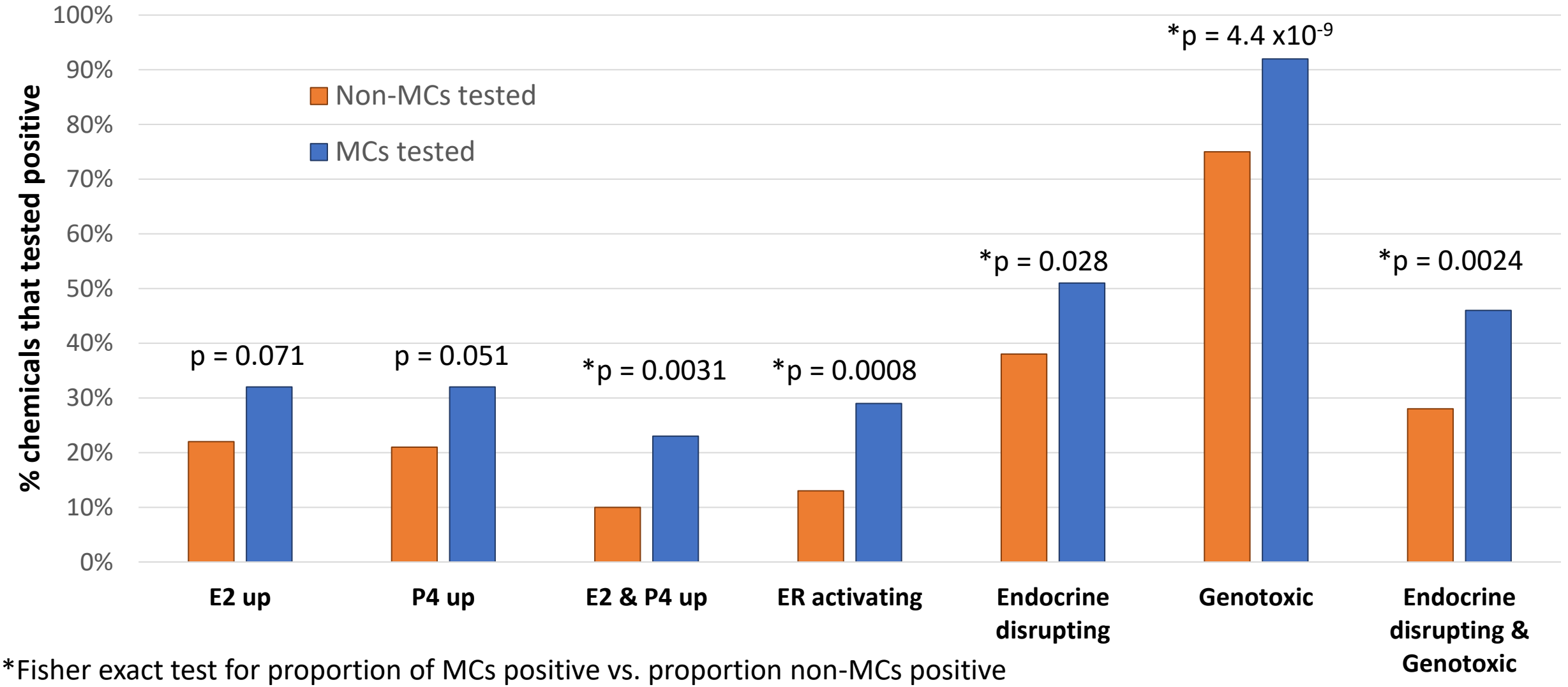
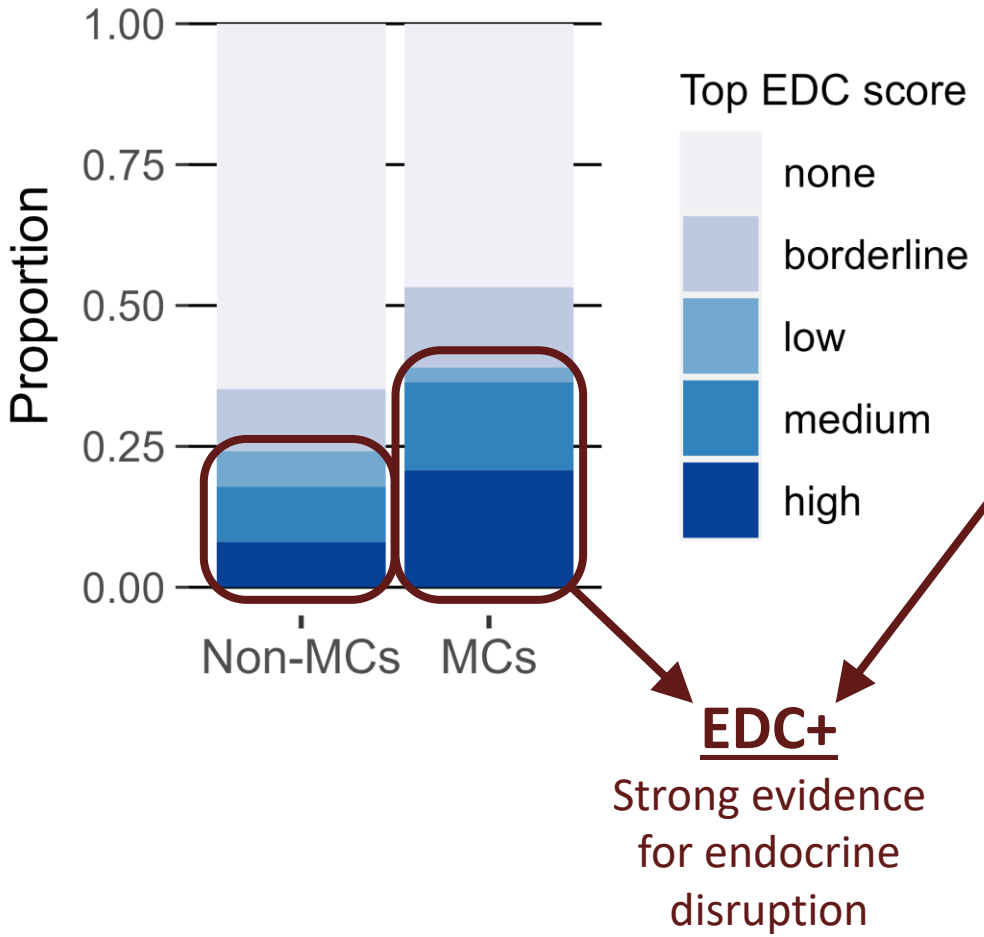
Endocrine disruption and genotoxicity are more common among chemicals that cause mammary tumors



*Fisher exact test for proportion of MCs positive vs. proportion non-MCs positive

Kay et al., EHP 2024, DOI 10.1289/EHP13233

MCs are more likely to be stronger EDCs



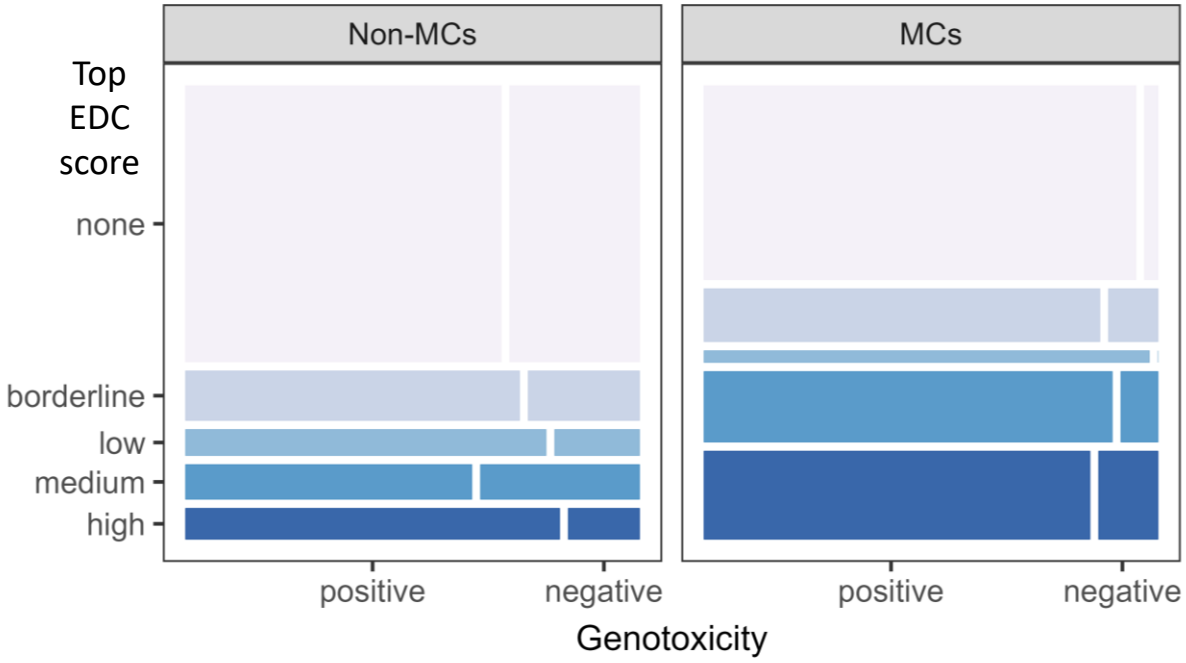
Top EDC score	% Non-MCs	% MCs	Fold-diff	p-value
High	8%	21%	2.6	***0.0015**[a]
Medium	10%	16%	1.6	0.16[a]
Low	6%	3%	0.4	0.29[a]
Borderline	11%	14%	1.3	0.44[a]
None	65%	47%	0.7	***0.0033**[a]
Trend[b]				***2.1 E-4**[b]

[a]Fisher exact test for proportion of MCs positive vs. proportion non-MCs positive

[b]Two-sided Cochran-Armitage trend test for strength of endocrine activity in MCs vs. non-MCs

Kay et al., EHP 2024, DOI 10.1289/EHP13233

MCs are more likely to be stronger EDCs *and* DNA-damaging (genotoxic)



Top EDC score	Gentox	% Non-MCs	% MCs	Fold-diff	p-value
High	+	6%	18%	2.9	***0.0032**[a]
Medium	+	5%	15%	2.9	***0.0084**[a]
Low	+	5%	3%	0.6	0.55[a]
Borderline	+	9%	11%	1.3	0.51[a]
None	+	47%	45%	1	0.79[a]
Trend[b]	+				***0.0012**[b]
High	-	**1%**	**3%**	3.2	0.21[a]
Medium	-	**3%**	**1%**	0.5	0.7[a]
Low	-	**1%**	**0%**	0	1[a]
Borderline	-	**3%**	**1%**	0.5	0.7[a]
None	-	**19%**	**1%**	0.07	***2.6 E-5**[a]
Trend[b]	-				***0.0024**[b]

[a]Fisher exact test for proportion of MCs positive vs. proportion non-MCs positive

[b]Cochran-Armitage trend test for strength of endocrine activity in MCs vs. non-MCs

Kay et al., EHP 2024, DOI 10.1289/EHP13233

Chemicals Most Likely to Increase Breast Cancer Risk in Humans

Mammary Carcinogens

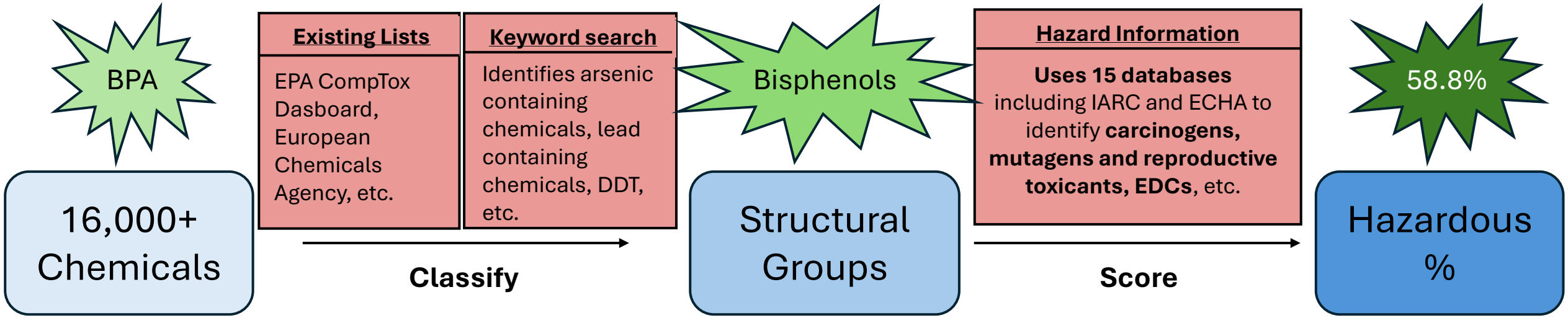
- Shown to cause mammary tumors in mammals
- Basis for extrapolation to humans

Genotoxic EDC+

- Combination of activities that cause breast cancer
- Most likely to induce mammary tumors in rodents, basis for extrapolation to humans

The PlastChem Database

Led by Martin Wagner at the Norwegian University of Science and Technology



15 priority groups of concern

- **Aromatic amines**
- Aralkyl aldehydes
- **Alkylphenols**
- **Salicylate esters**
- Aromatic ethers
- **Bisphenols**
- **Phthalates**
- **Benzothiazoles**
- **Organometallics**
- **Parabens**
- **Azodyes**
- **Aceto/benzophenones**
- Chlorinated paraffins
- **Per- and polyfluoroalkyl substances (PFAS)**

Prioritize

Wagner et al., Zenodo 2024, DOI 10.5281/zenodo.10701705

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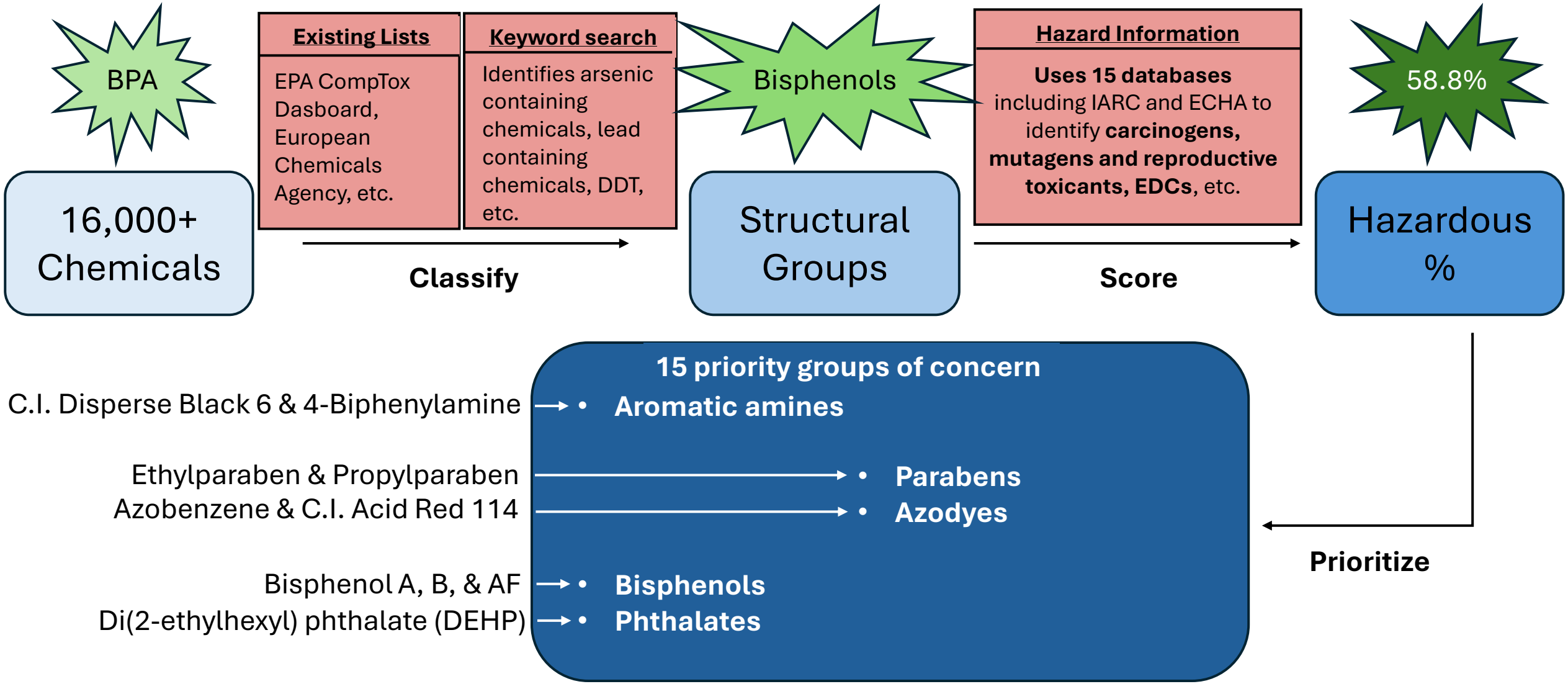

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Carcinogens in Plastics… and Unknown Hazards

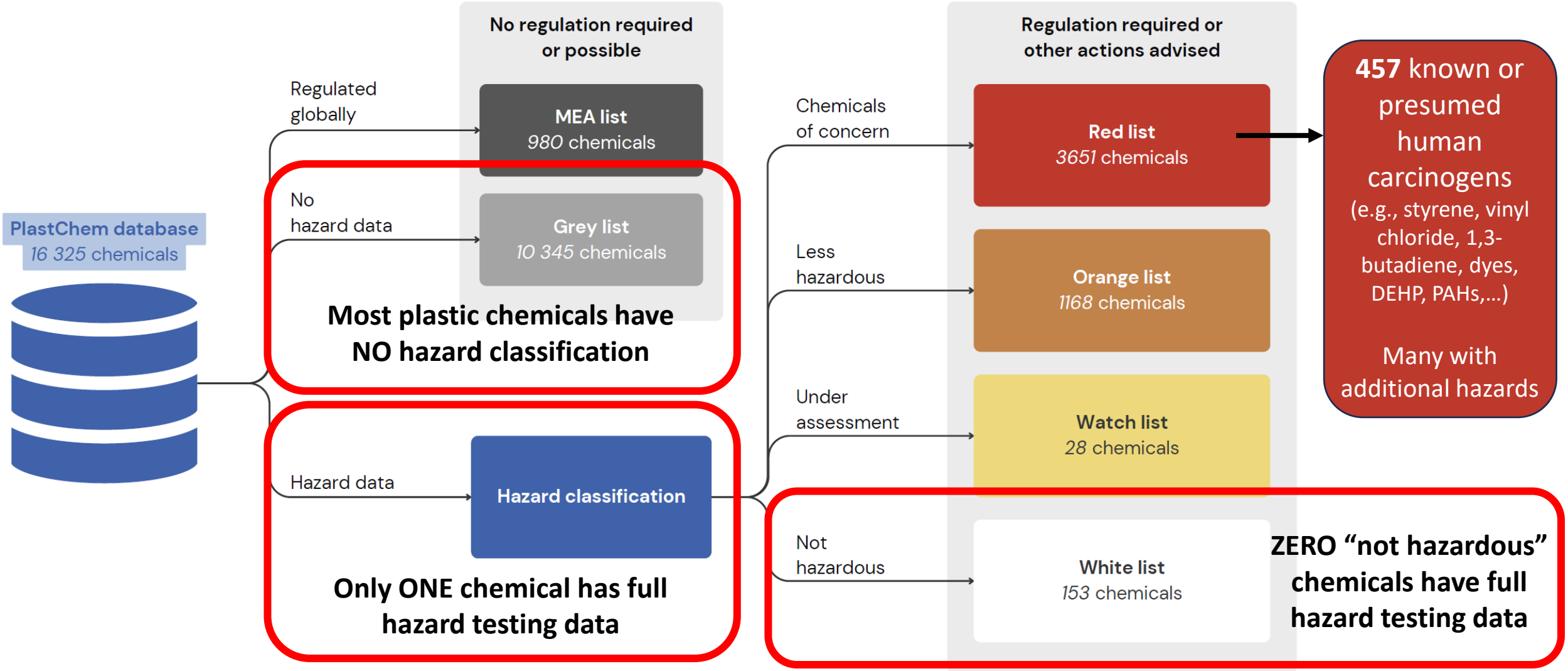


Figure 14: Overview of the six PlastChem lists.

Wagner et al., Zenodo 2024, DOI 10.5281/zenodo.10701705

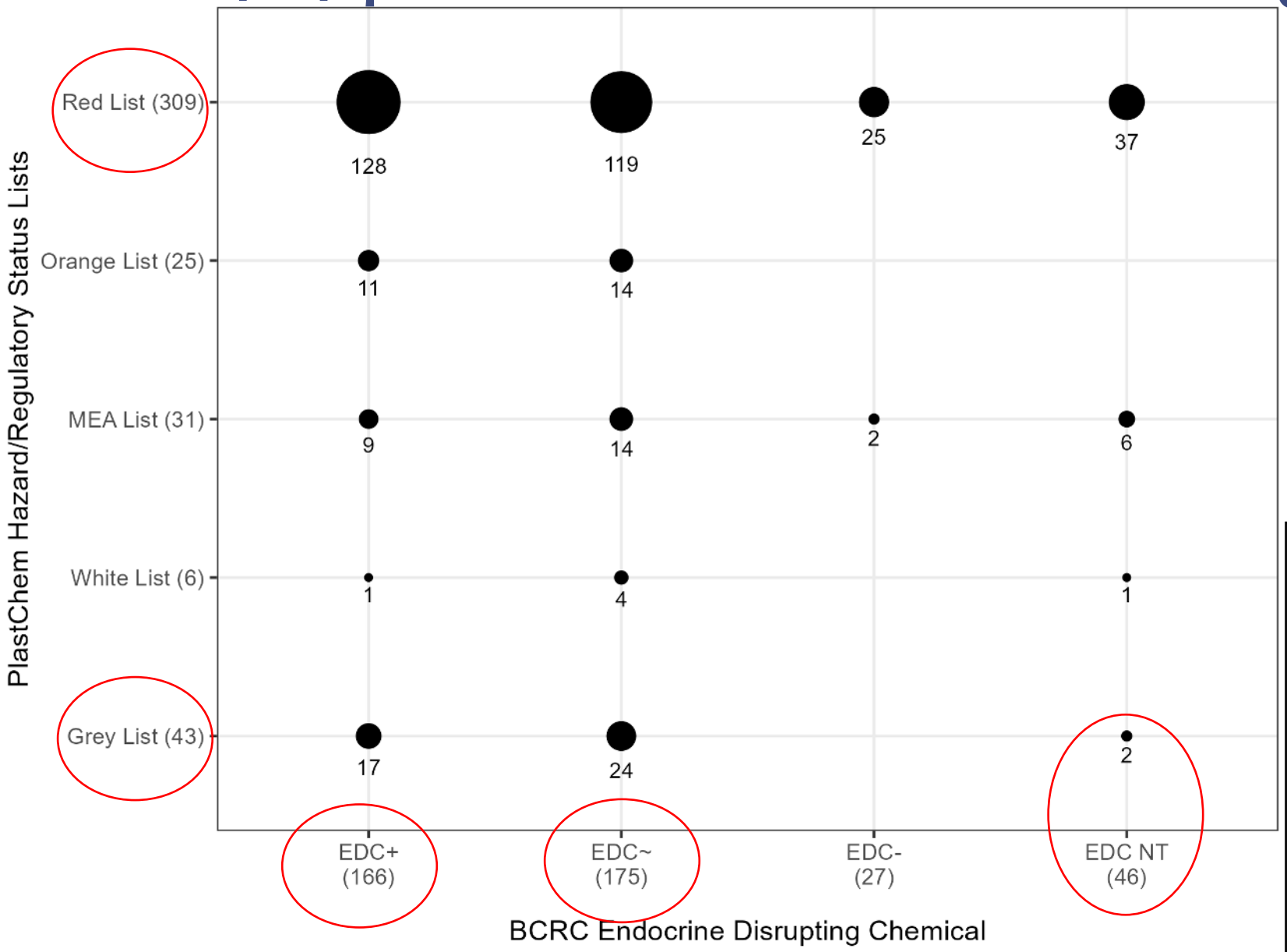
Carcinogens in Plastics… and Unknown Hazards

	Regulated under MEAs	Proposed for Regulation	Not Regulated Under MEAs
Hazardous	MEA List	Orange List	Red List
Less Hazardous	MEA List	Orange List	Orange List
Not Hazardous	MEA List	N/A	White List
No Hazard Data	N/A	Grey List	Grey List

Figure 14: Overview of the six PlastChem lists.

Wagner et al., Zenodo 2024, DOI 10.5281/zenodo.10701705

The 414 potential breast carcinogens in plastics



166 EDC+
175 EDC~
} 341 endocrine disrupting

309 Red List

41 Grey List EDCs

Key:

PlastChem Hazardous/Regulatory Status Lists

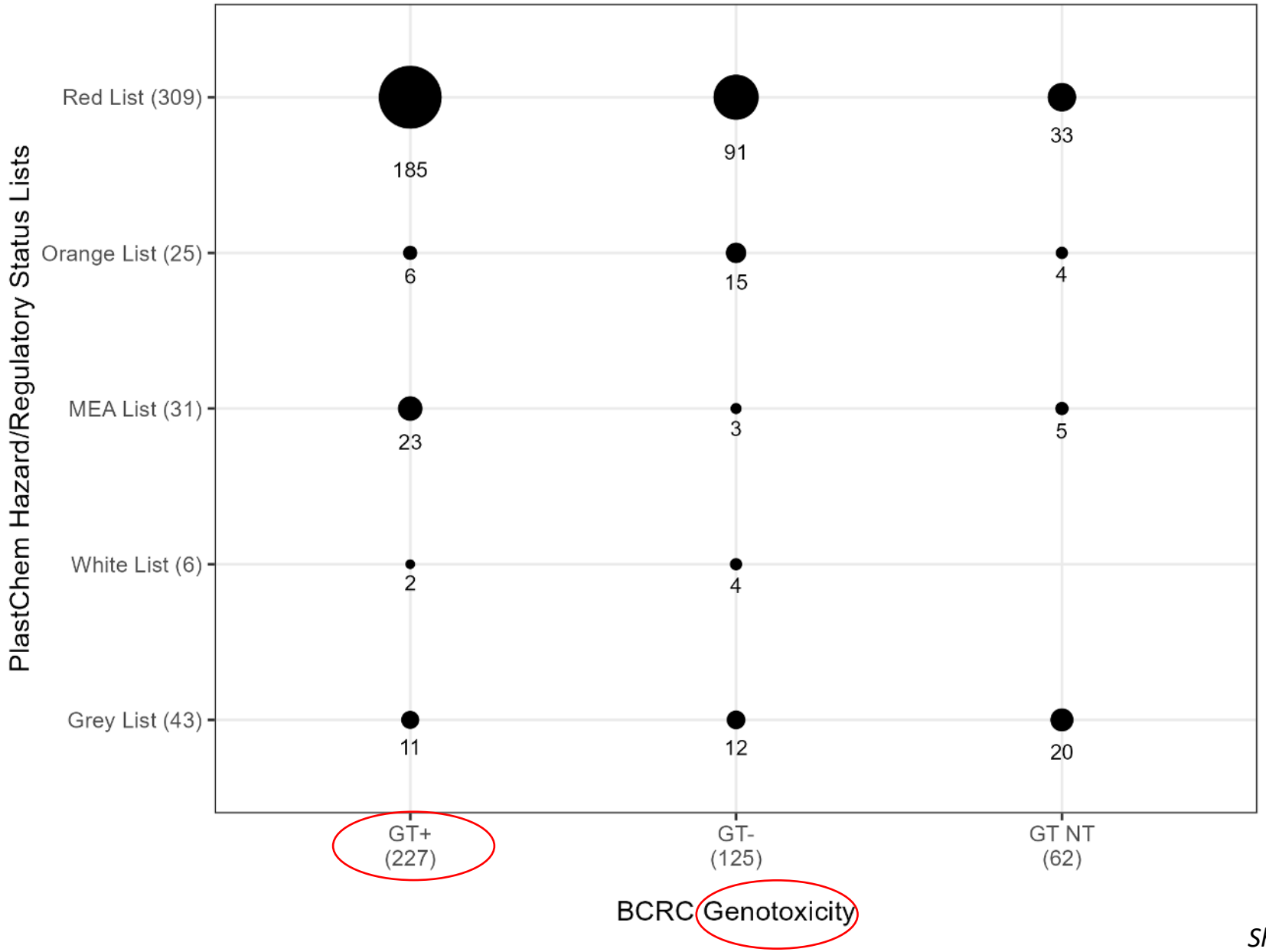
Red List contains chemicals classified as hazardous and underregulated, Orange List = classified as less hazardous and/or proposed for regulation, MEA List = regulated under MEAs, White List = classified as not hazardous, Grey List = no hazard data

Toxicity Characteristics

For EDC (endocrine activity) and GT (genotoxicity), + indicated positive, ~ borderline, - negative, and NT not tested.

Shakti et al., ES&T 2024, DOI 10.1021/acs.estlett.4c00942

The 414 potential breast carcinogens in plastics



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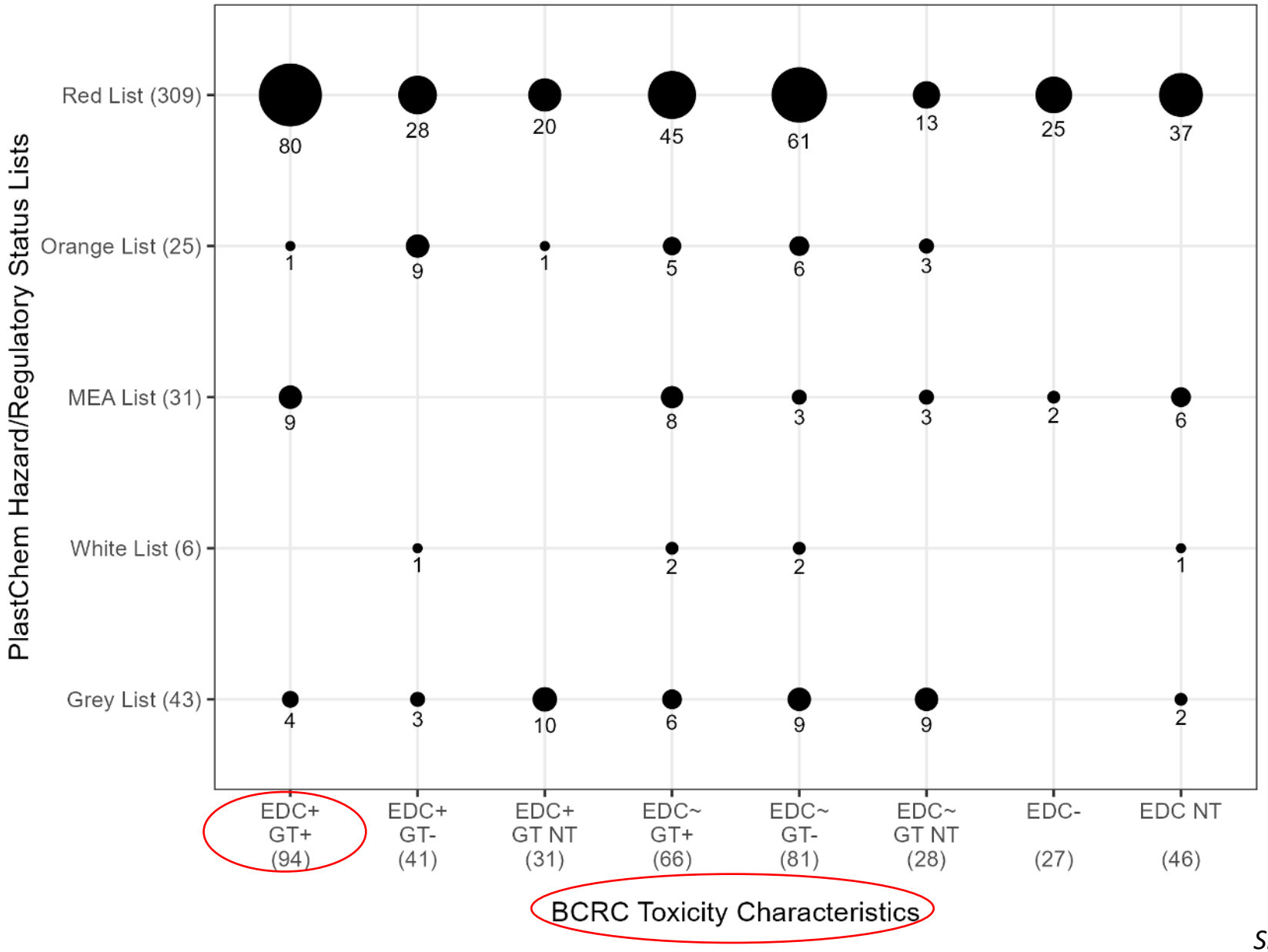

166 EDC+
175 EDC~
} 341 endocrine disrupting

309 Red List

41 Grey List EDCs

227 Genotoxic

94 Genotoxic EDC+

...plus 81 mammary carcinogens that aren't genotoxic EDC+

Equals 175 potential breast carcinogens to prioritize

Key:

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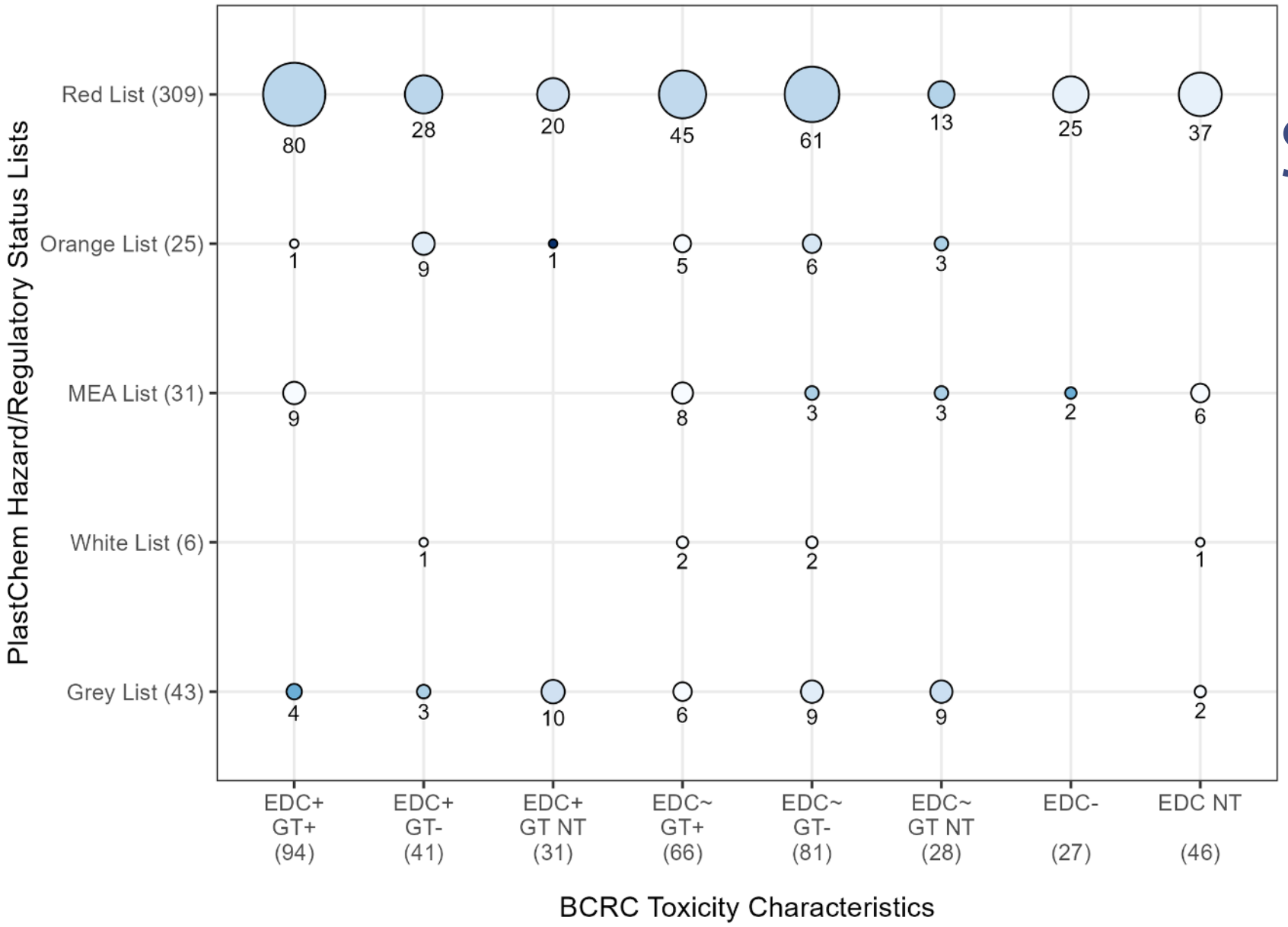
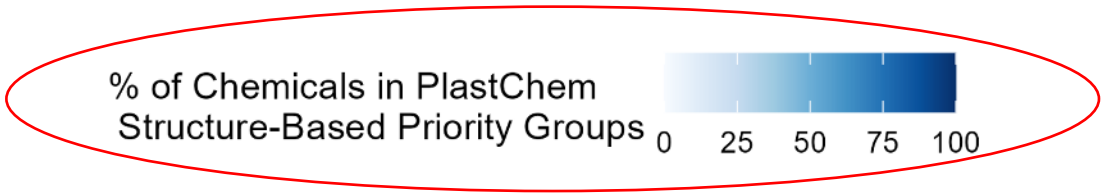
Adding Priority Structure Groups





88 potential breast carcinogens belong to PlastChem Priority Groups

Key:

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Our Asks

- Regulation, including a global plastics treaty that:
- Prioritizes potential breast carcinogens, especially the 175 with strongest evidence
- Addresses data gaps:

Problem	Solution	Example
Barriers in epidemiology	In-vitro and in-vivo data	Endocrine disruption in cells suggests effects in humans
Chemicals lacking in data	Integrate more types of data	41 potential breast carcinogens on the Grey List
Slow actions and regrettable substitutions	Take a cautious approach using structural similarities	PlastChem: prioritizes groups containing >40% hazardous chemicals

Conclusions

- Breast cancer is on the rise, and chemical exposures likely play a role
- We identified 414 potential breast carcinogens in plastics
  - 175 are highest priority for breast-carcinogenic biological activity
  - 88 are in hazardous structural groups prioritized by PlastChem Project
- Efficient and cautious approaches to reduction
  - Act on available data to prevent harm, even if not clearly shown in humans
  - Regulate chemicals as groups, not one-by-one
- **Reducing exposures to chemicals in plastics can likely reduce breast cancer risk**

Thank you!

Why the UN Treaty on Plastics Can Reduce Early Onset Cancers
Rashmi Shakti, Jennifer E. Kay, Elissia T. Franklin, Jennifer L. Ohayon, Julia G. Brody, Mary Beth Terry, Ruthann A. Rudel

https://pubs.acs.org/doi/10.1021/acs.estlett.4c00942

Application of the Key Characteristics Framework to Identify Potential Breast Carcinogens Using Publicly Available *in Vivo*, *in Vitro*, and *in Silico* Data
Jennifer E. Kay, Julia Green Brody, Megan Schwarzman, Ruthann A. Rudel

https://ehp.niehs.nih.gov/doi/10.1289/EHP13233

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