

Adverse impacts of endocrine-disrupting chemicals in plastics, personal products, and food:

Considerations and recommendations from an academic research scientist.

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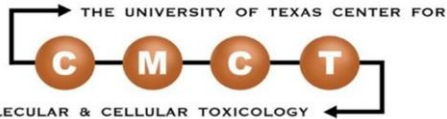
Who am I?

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National Institute of Environmental Health Sciences
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Dr. Andrea Gore



Supported development of Endoscreen.org



Sex-specific effects of endocrine-disrupting chemicals on brain monoamines and cognitive behavior

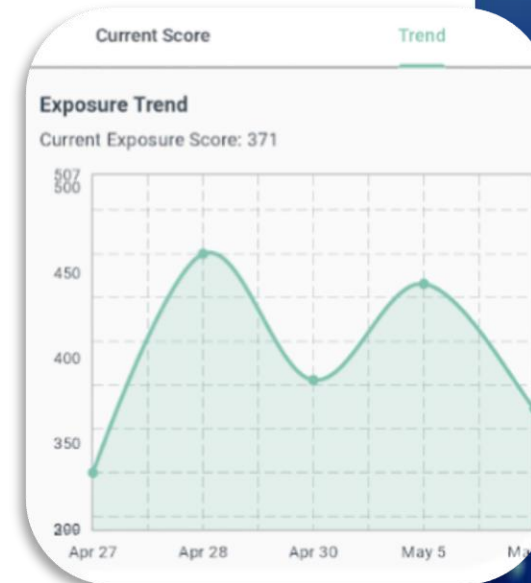
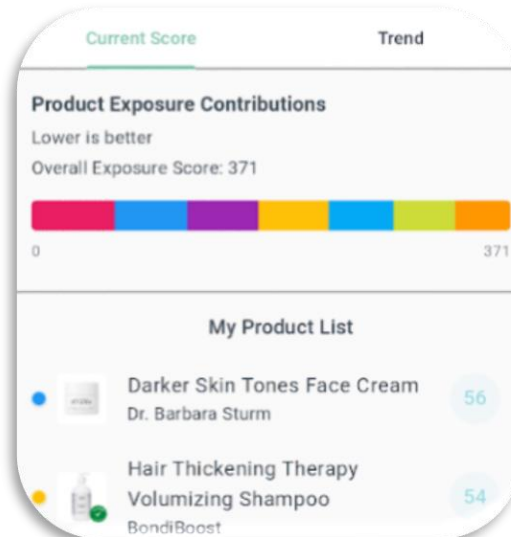
EN Hiltz, AC Gore
Endocrinology 163 (10), bqac128

Endocrine-disrupting chemicals: science and policy

EN Hiltz, AC Gore
Policy insights from the behavioral and brain sciences 10 (2), 142-150

Two hits of EDCs three generations apart: evaluating multigenerational anxiety-like behavioral phenotypes in female rats exposed to Aroclor 1221 and Vinclozolin

EN Hiltz, R Gillette, LM Thompson, L Ton, T Pham, MN Kunkel, D Crews, ...
Environmental health perspectives 132 (12), 127005



Endoscreen GooglePlay app

Neuroscientist

Environmental toxicologist

Political advocate

App developer

The endocrine system is the body's primary communication network and regulates many bodily processes.

What are endocrine disruptors?

chemicals that disturb the body's hormone systems and cause cancer, diabetes, reproductive disorders, and neurological impairments in developing fetuses and children.



VERY LOW DOSES CAN CAUSE HARM

Amounts which are usually considered "safe" for consumers are based on traditional risk assessment methods that often do not capture effects on hormones.



POTENTIAL DELAYED EFFECTS

Effects can occur years after exposure. Moreover, adverse health effects may affect multiple generations.



IRREVERSIBLE HEALTH DAMAGE

During windows of high vulnerability, a woman's health can be damaged beyond repair.

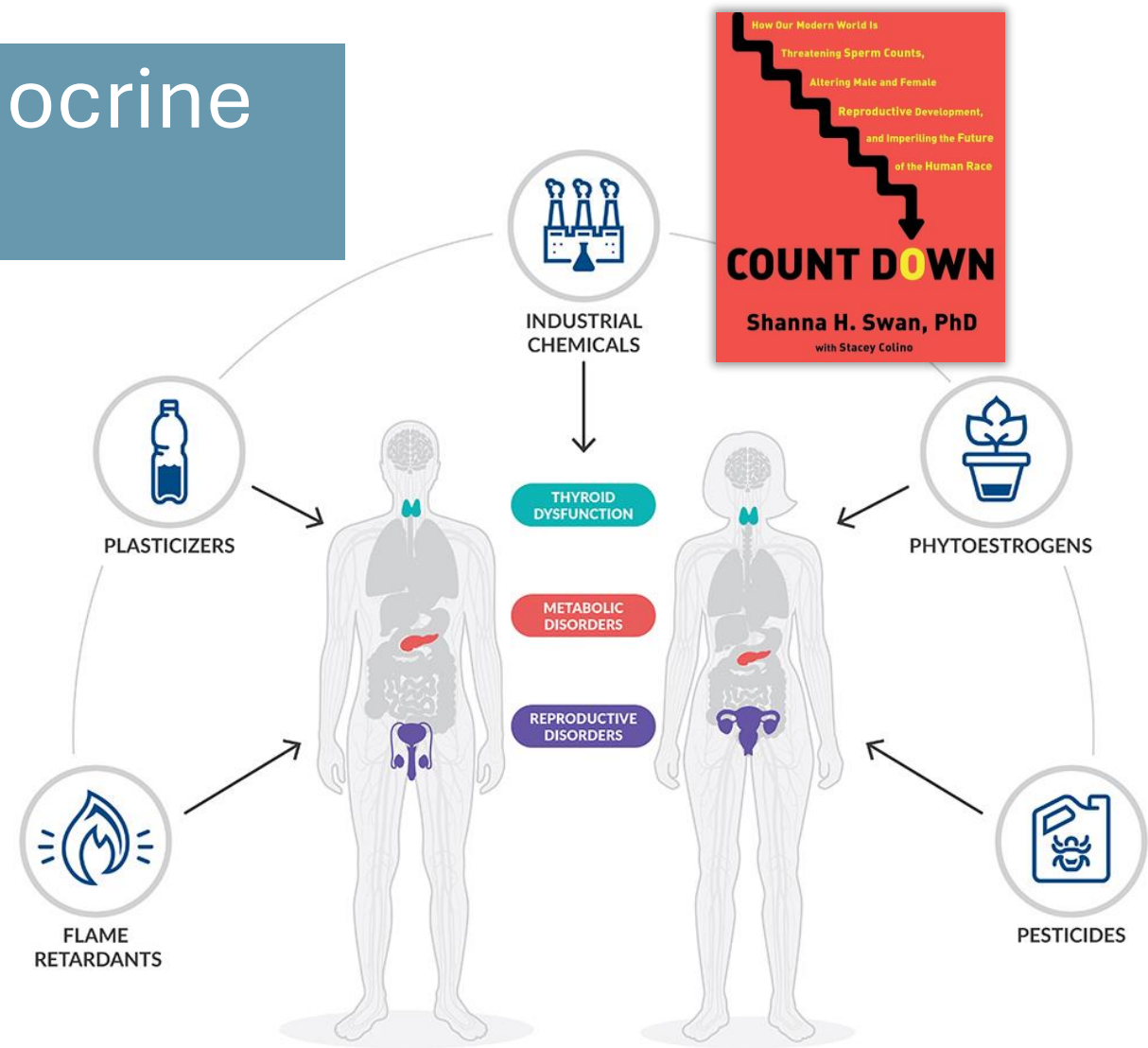


EFFECTS LARGELY OVERLOOKED

Current regulatory testing strategies lack adequate test methods to identify EDCs.

Major health concerns of endocrine disruptors

- **Male fertility is declining** – sperm counts reduced by 40% worldwide (Levine et al., 2017).
- **Breast cancer** diagnoses in women under 40 is **increasing** by 3% every year, recently overtook lung cancer as #1 cause of cancer-related death in women (Fernandes et al., 2023).
- Worldwide **obesity** has more than **doubled** since 1980; can't be explained by lifestyle factors alone (Haverinen et al., 2021).
 - Obesogens and Diabetogens



Although public awareness of the harmful effects of industrial chemicals is high, awareness of personal routes of exposure is much lower.

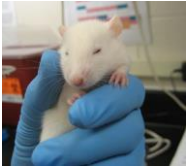
Endocrine-mediated diseases target tissues and cells of the endocrine system.

Interfere with signaling in endocrine cells, affecting hormone production and balance.

BIOLOGICAL SYSTEMS AFFECTED BY EDC EXPOSURE.	
SYSTEM	Research Articles
ADRENAL	172
CANCER	453
CARDIO-VASCULAR	48
CELL DAMAGE	475
COGNITIVE-BEHAVIORAL	330
DEVELOPMENTAL	178
DIGESTIVE	12
GENETIC	107
HEPATIC	312
IMMUNE	219
INFLAMMATION	20
METABOLIC	491
NEUROLOGICAL	428
PREGNANCY	261
REPRODUCTIVE	2203
RESPIRATORY	18
SKELETAL	74
THYROID	366
TUMORS	129

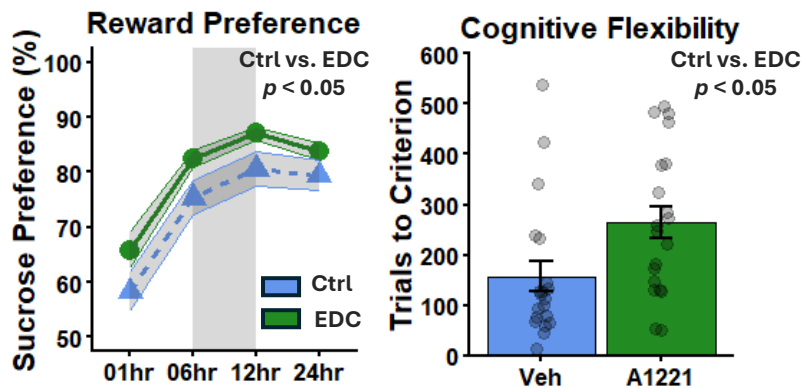
Data collated November 2023
Endoscreen.org

Research example: EDCs promote cognitive disruptions over generations via effects on the brain.



Grandchild of rat exposed to EDCs

Behavior tests of ADHD in rats:



- A1221 is a banned chemical our parents/grandparents were exposed to (PCBs, 1940s-1970s).
- Increased reward preference.
- Reduced attentional/cognitive function.
- Hallmark ADHD.

Brain genetic makeup:

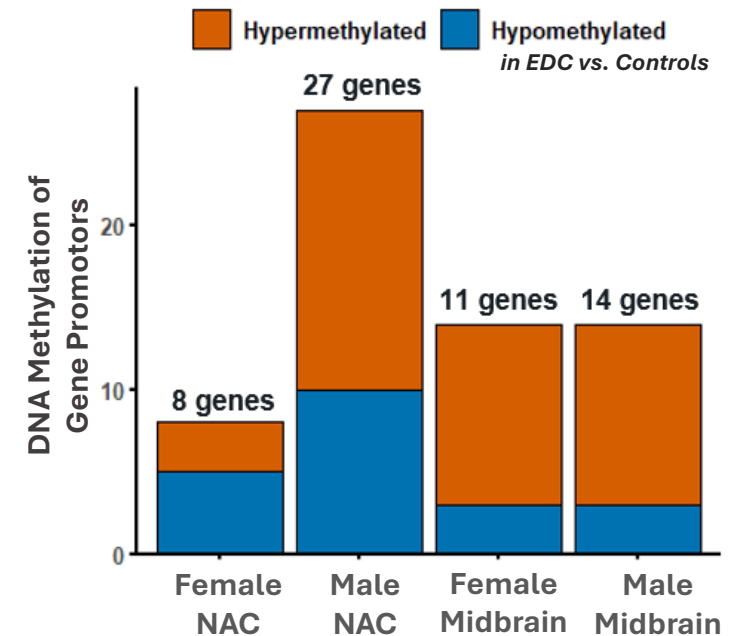
genes disrupted in EDC rats

	Male	Female
Nucleus accumbens	893	156
Midbrain	369	457

RNA sequencing

- Dopamine, estrogen, and synaptic signaling affected.
- Nucleus accumbens highly sensitive – 893 different genes. Important reward region!
- These gene changes predict behavior.

Epigenetic (heritable) marks:

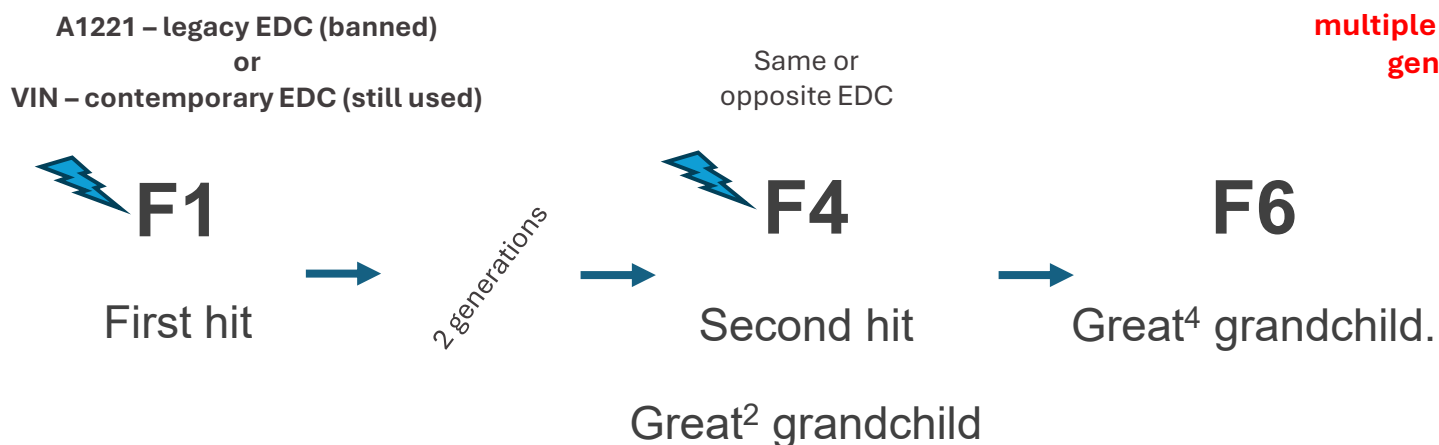


- All regions methylated – esp. NAC.
- Possible mechanism for heritability.

Research example: Historical exposures shape contemporary health.

NIEHS study (Andrea Gore) defining transgenerational effects of different EDC combinations – legacy versus contemporary contaminants.

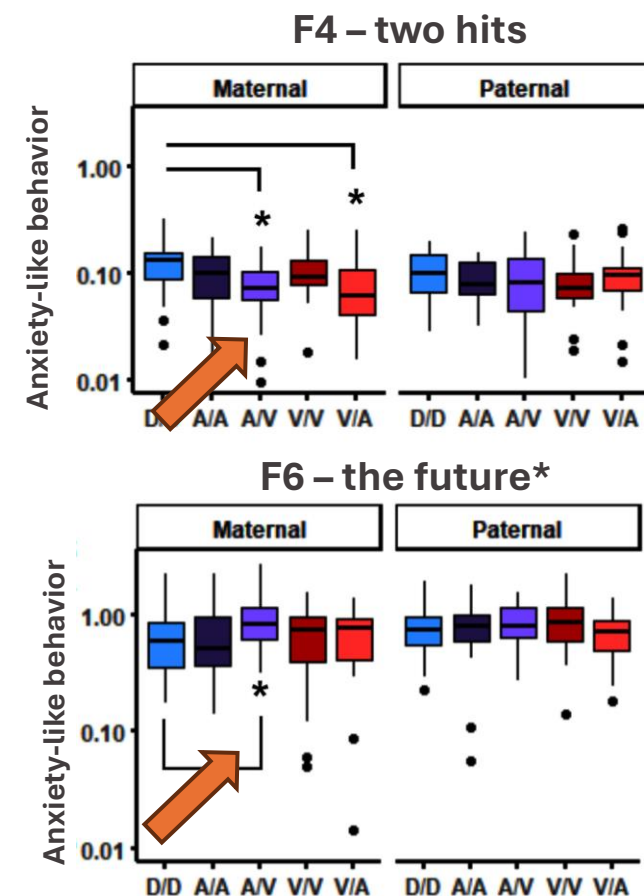
1,437 rats in six generations!



Diverse effects
associated with
multiple hits along the
genetic line.

The most consistently affected exposure group is also the most relevant to humans – legacy followed by contemporary exposure.

“emergent effects”



D = DMSO control
A = A1221, V = VIN

Research example: Complex EDC mixtures, at very low levels, interact and contribute to obesity.

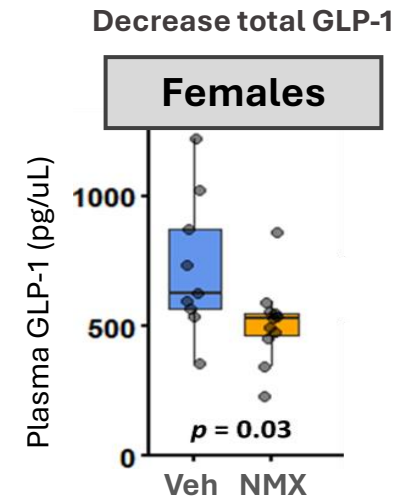
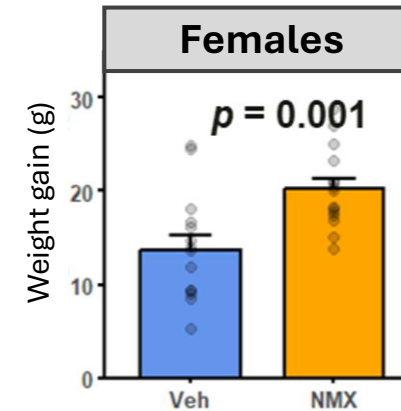
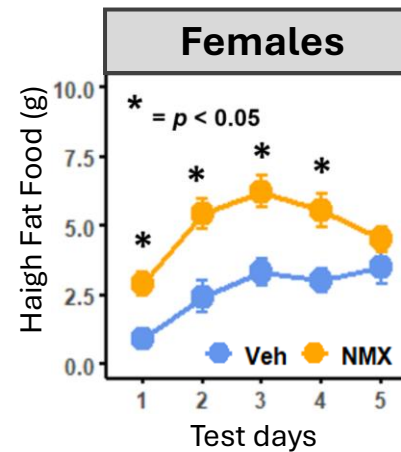
Humans are not exposed to EDCs one at a time! How many different things do you use in the morning?

Common EDC types and routes of exposure

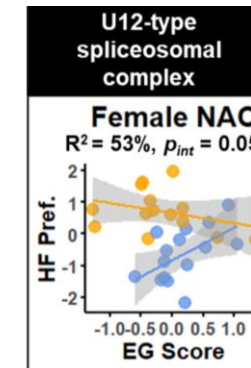
Class	History of use
Bisphenols	Used in plastics, food packaging, and thermal paper
Phthalates	Used in plastics, personal care products, and some medications
Per- and polyfluoroalkyl substances (PFAS)	Used in nonstick coatings, waterproofing materials, and firefighting foam
Pesticides	Used in agriculture and insect control
Polychlorinated biphenyls (PCBS)	Used in electrical equipment, industrial applications, paints, plastics, and adhesives
Polybrominated diphenyl ethers (PBDES)	Used as flame retardants in electronics and furniture
Parabens	Used as preservatives in personal care products and some foods

“NeuroMix”
Low-dose

EDCs increase fatty food eating
(and associated weight gain)



708 differently expressed genes in the **Nucleus Accumbens**



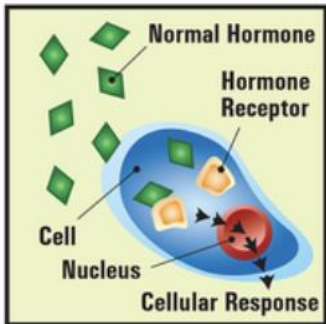
EDCs change the way our genes are shaped and how they work.

Endocrine disruptors in plastic:

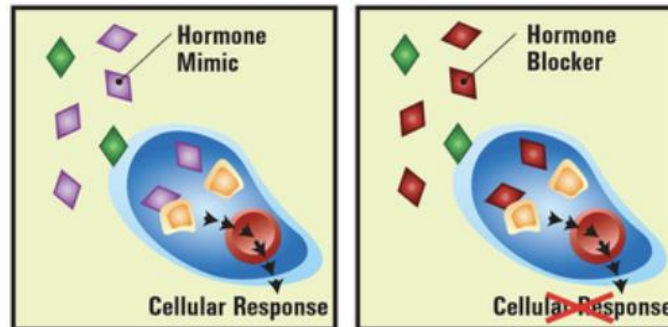
According to the U.S. Endocrine Society, 144 chemicals known to be hazardous to human health are used in

- antimicrobials
- colorants
- flame retardants
- plasticizers
- solvents
- UV-stabilizers

Normal Endocrine Signaling



Endocrine Disrupting Chemicals*



** Other EDC mechanisms of action may include disruption of hormone synthesis, impairment of cell signaling, and other effects.*



EDCs commonly used in plastic:

Bisphenols

- Used to make polycarbonate plastics and epoxy resins.
- Leach into food and beverages over time.
- BPA affects fertility, reproductive development and function, brain development, metabolic system (thyroid), and associated with increased cognitive disorders in children.
- Over 7,000 research papers support harmful effects of BPA; many countries (including the U.S.) have restricted or banned its use.

Phthalates

- Used to produce or promote flexibility (plasticizers) and stabilize PVC.
 - Medical devices, food packaging, children's toys, personal care products..
- Exposure occurs via oral ingestion, inhalation, and skin contact.
- Reduces testosterone and estrogen levels, blocks thyroid hormone action, and are reproductive toxicants. Cause malformation of the male reproductive system.
- Some phthalates (DEHP, DBP) are banned for use in children's toys in the U.S.

U.S. Endocrine Society & IPEN Plastics report, 2020

EDCs commonly used in plastic:

Perfluorinated chemicals

- PFAS
- Used to make fluoropolymers for plastics (nonstick surfaces with high temperature resistance – pipes, valves, pumps)
- Primarily exposed through water; also cookware and fast-food wrappers.
- PFAS affect the immune system, liver, and thyroid function. They alter puberty, raise breast cancer risk, and are associated with endocrine-mediated cancers.

Brominated Flame Retardants (BFRs)

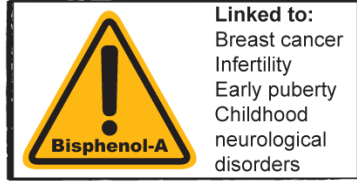
- Used to reduce flammability in plastic products.
 - Electronic casings and wire coatings, plastic children's toys, and recycled plastics,
- Exposure occurs via inhalation (dust), and oral contact (children chewing products).
- BFRs disrupt male and female reproductive development, alter thyroid development, and affect neurodevelopment. BRF exposure is associated with psychomotor and attention-related IQ performance in children.

THE STORY BEHIND BISPHENOLS

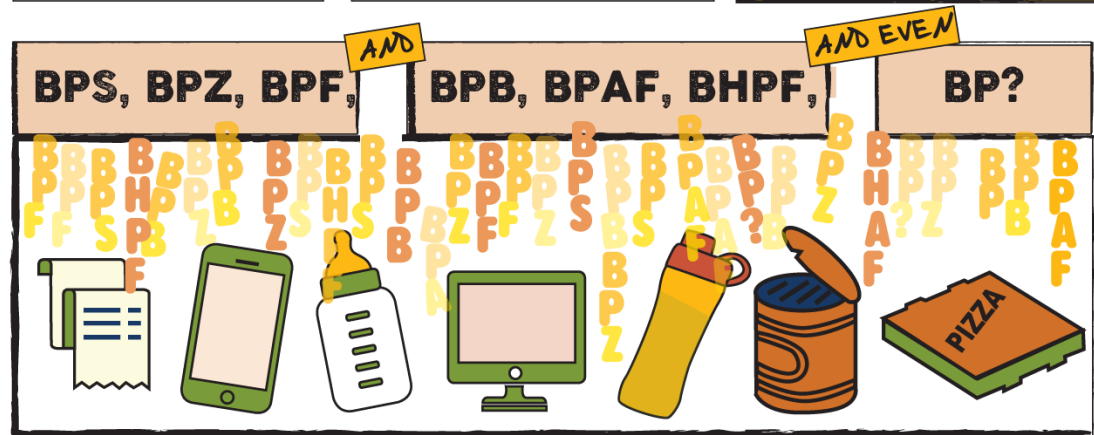
Once upon a time...



Then it was discovered...



People started to...

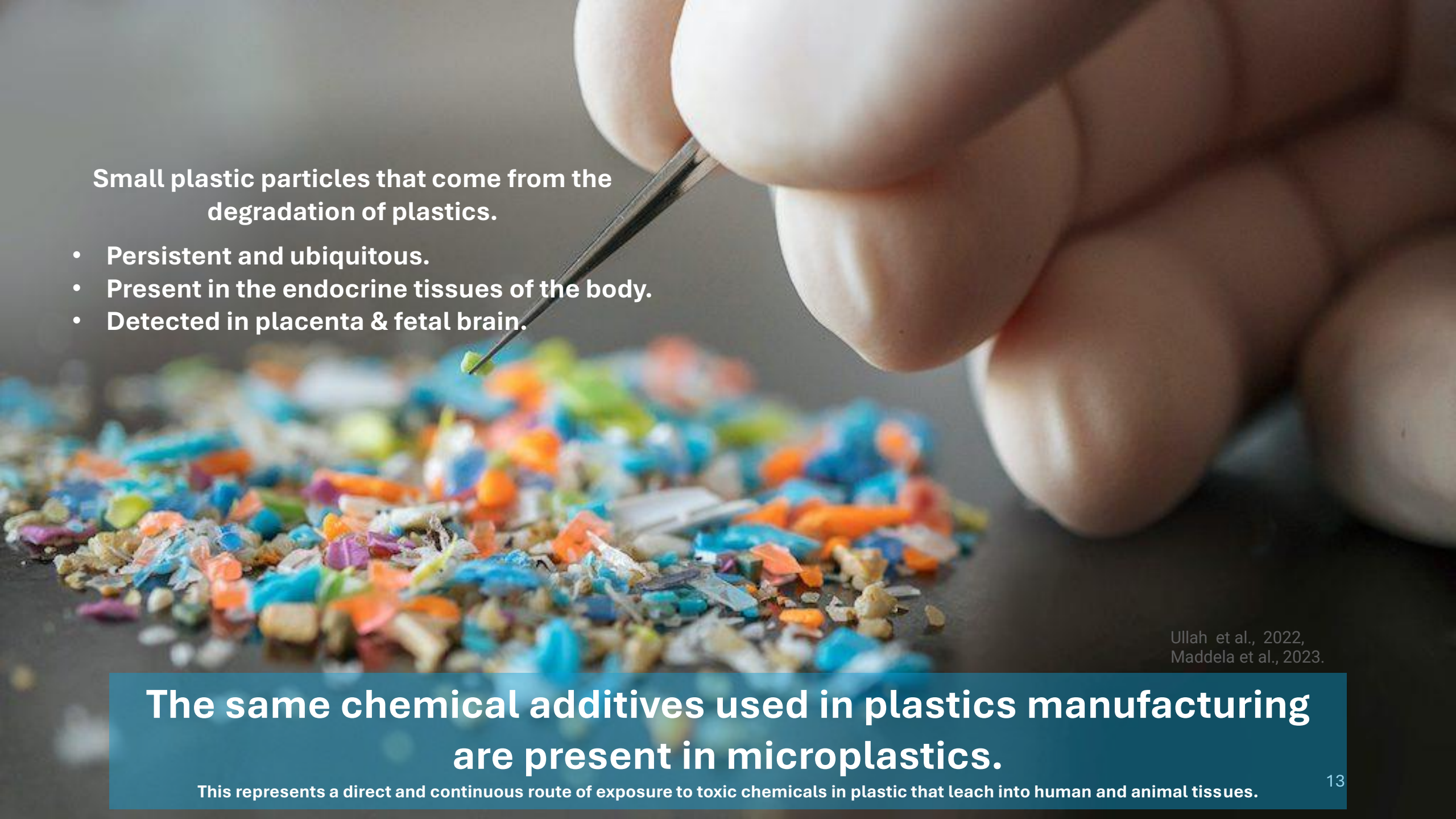


**Just because a product says it is BPA-free,
does not mean there are no health impacts.
Companies are replacing BPA with chemicals
that are just as worrying. From BPA to BPZ.**

Regrettable substitution

Replacing a harmful chemical with a structurally similar substitute that has similar or even worse toxicological effects.

- **BPA is canonical example – substitute bisphenols are used in products labeled BPA-free.**
 - Many of those bisphenols have been found to be similarly harmful but receive less public attention.
- Other examples: Phthalates, PFAS -> GENX, PCBs -> PBDEs -> OEFRs
 - Scientific scrutiny cannot keep up with next gen chemical manufacturing; it takes years to identify the EDC-potential of a single chemical.



Small plastic particles that come from the degradation of plastics.

- Persistent and ubiquitous.
- Present in the endocrine tissues of the body.
- Detected in placenta & fetal brain.

Ullah et al., 2022,
Maddela et al., 2023.

The same chemical additives used in plastics manufacturing are present in microplastics.

This represents a direct and continuous route of exposure to toxic chemicals in plastic that leach into human and animal tissues.

Are plastic replacements better?

Plastics recycling compounds the issue.

When plastics are recycled, the process often involves the melting and re-forming of plastic materials.

- The mechanical and heat stress applied during recycling can create a less stable plastic from which EDCs more easily leach.
- Plastic degradation not only frees bound EDCs, but also can generate new harmful compounds.

IPEN, 2021
Carmona et al., 2023



Are plastic replacements better?

Bioplastic is a biodegradable material that comes from renewable sources and can be used to reduce the problem of plastic waste.

- Researchers have found that most bioplastics—including those made from plants—contain the same chemical additives as traditional plastics with similar toxic profiles.

Zimmermann et al., 2020



Recommendation: Replace plastics in food and product packaging.



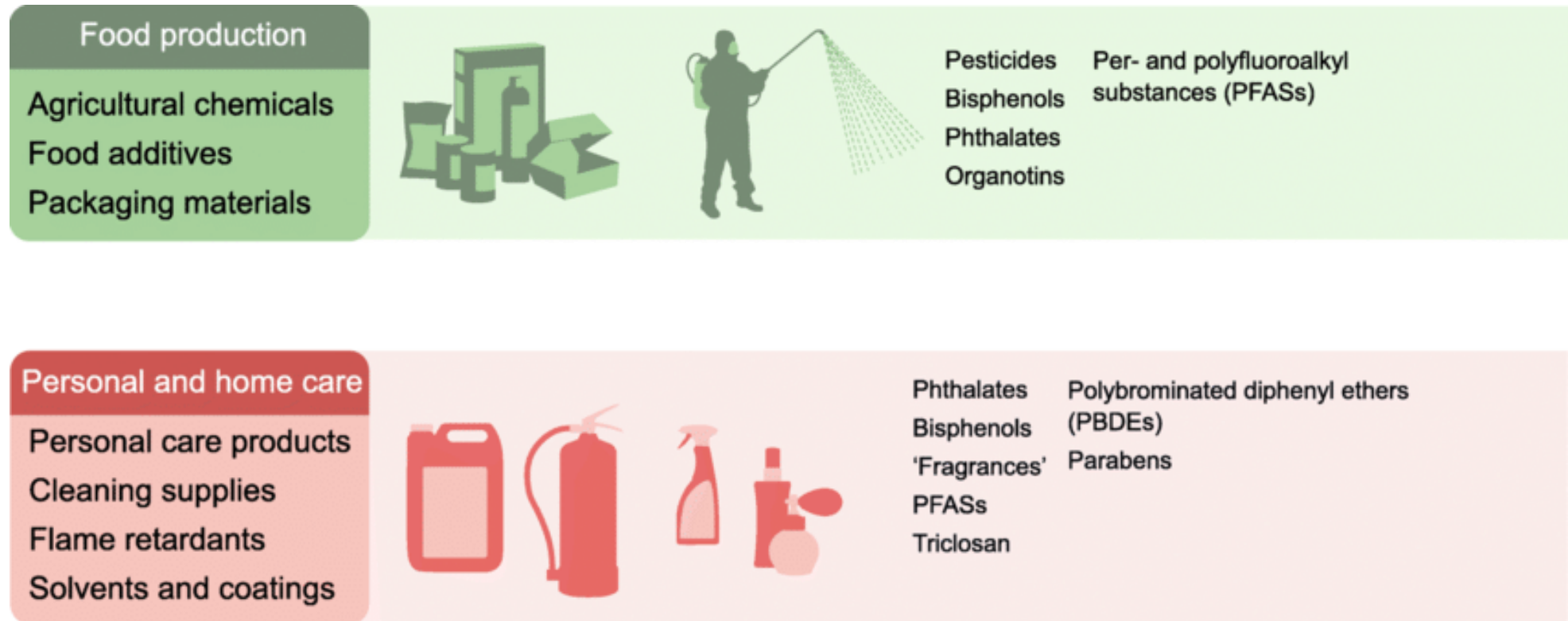
The best way to reduce exposure to plastics is to reduce the use of plastics – *traditional, recycled, and bioplastics* – in manufacturing and in life.

- Invest in natural packaging.
- Use ceramic, glass, wood, or metals for packaging – mind coatings.
 - Plastic containers and kitchen products release thousands of microplastics into food.

Yadav et al., 2023

Endocrine disruptors are used for many purposes beyond plastics production.

The same chemical additives used in plastics are used across a wide range of product manufacturing:



This is because the physiochemical properties of EDCs can help maintain shelf-life, act as emulsifiers, improve packaging stability, etc.

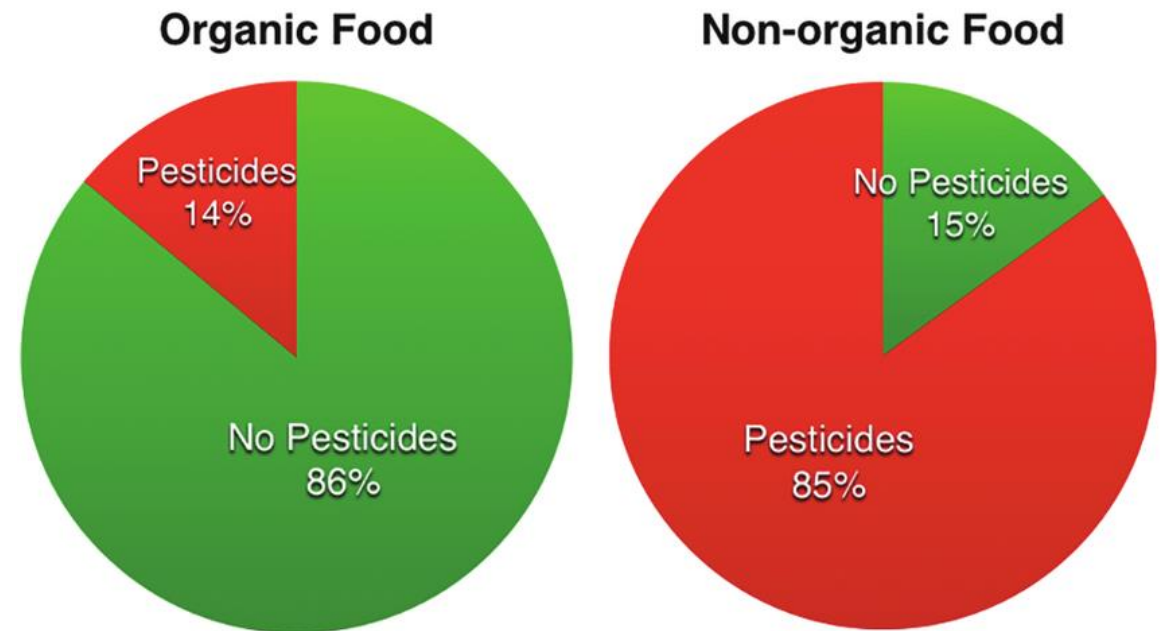
Food as a route for endocrine disruption

Food produced using contemporary agricultural practices has measurable pesticidal and insecticidal residues.

- Organochlorines, organophosphates, pyrethroids
 - DDT, chlorpyrifos, atrazine, and glyphosate
- Toxic at high levels
- Endocrine-disruptors at low levels

Food packaging is another source of exposure

- plasticizers/microplastics,
- non-stick coatings,
- stabilizers.



Diet can be a great tool for reducing our exposures to EDCs.



The American Journal of Clinical Nutrition

Volume 114, Issue 2, August 2021, Pages 669-682



Dietary quality and bisphenols: trends in bisphenol A, F, and S exposure in relation to the Healthy Eating Index using representative data from the NHANES 2007–2016

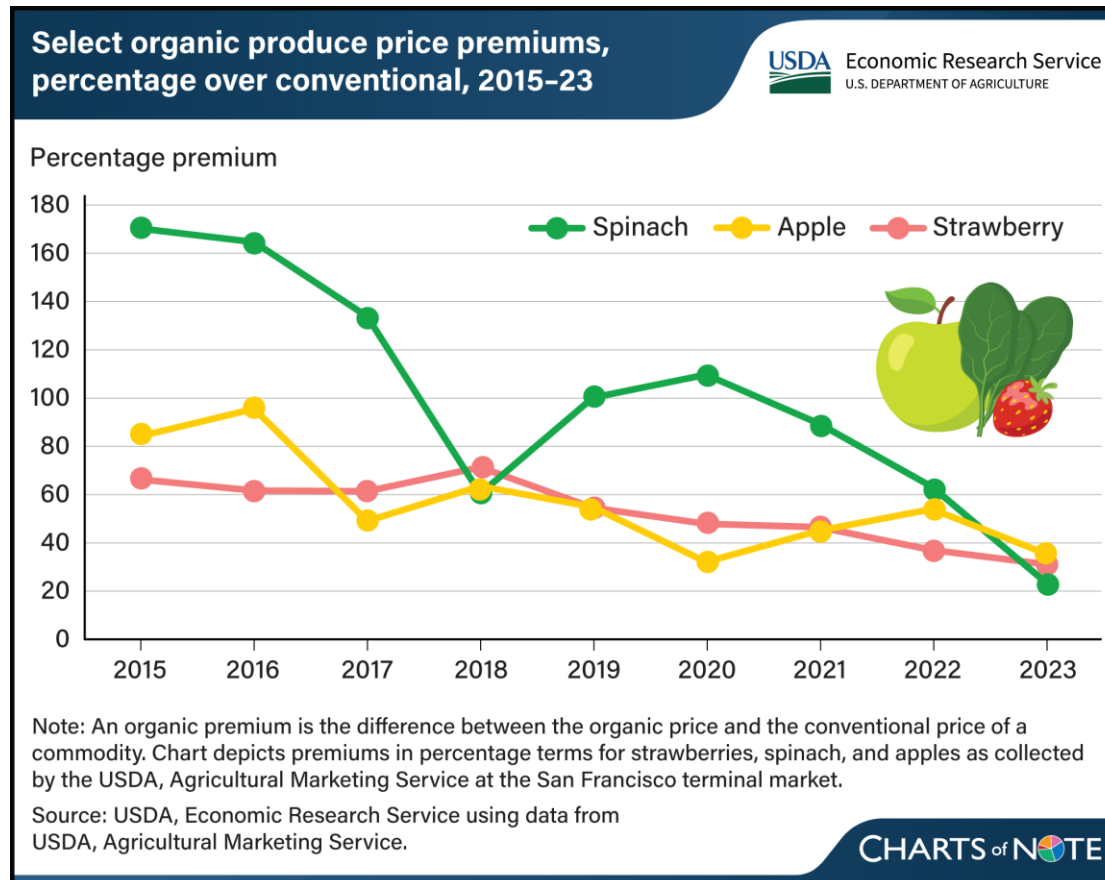
Irene van Woerden ¹  , Devon C Payne-Sturges ², Corrie M Whisner ³, Meg Bruening ³

Improved dietary quality is associated with lower BPA and BPF concentrations in urine.

- Higher scores for total fruits, whole fruits, total vegetables, and whole grains were associated with lower bisphenol concentrations.
- Higher intakes of plain and tap water were associated with lower BPA & BPS concentration.
- Bottled water intake, and more meals from fast food or frozen meals, was associated with higher BPA concentration.

These chemicals are well-known to impair neurological development in children and reproductive/metabolic processes in adults.

Recommendation: Invest in organics

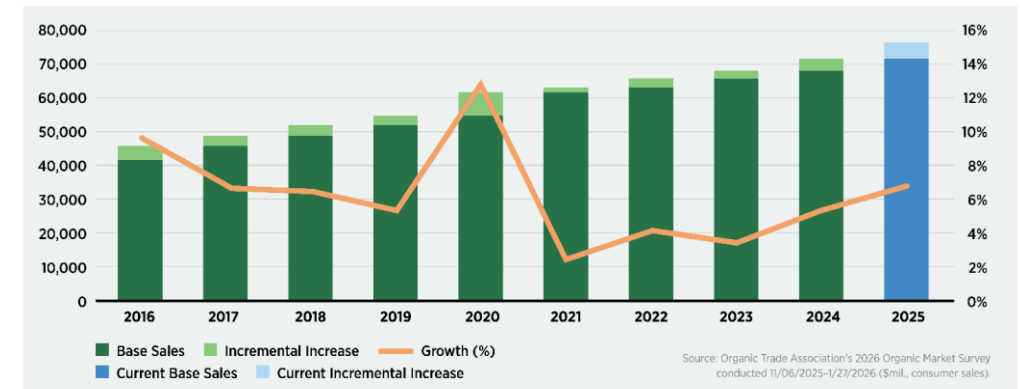


The cost of organic food is steadily decreasing while consumer demand increases.

Companies that invest in organic agriculture will see increasing returns in years to come.

Up from 2% in 2012

Total U.S. Organic Sales & Growth, 2016-2025

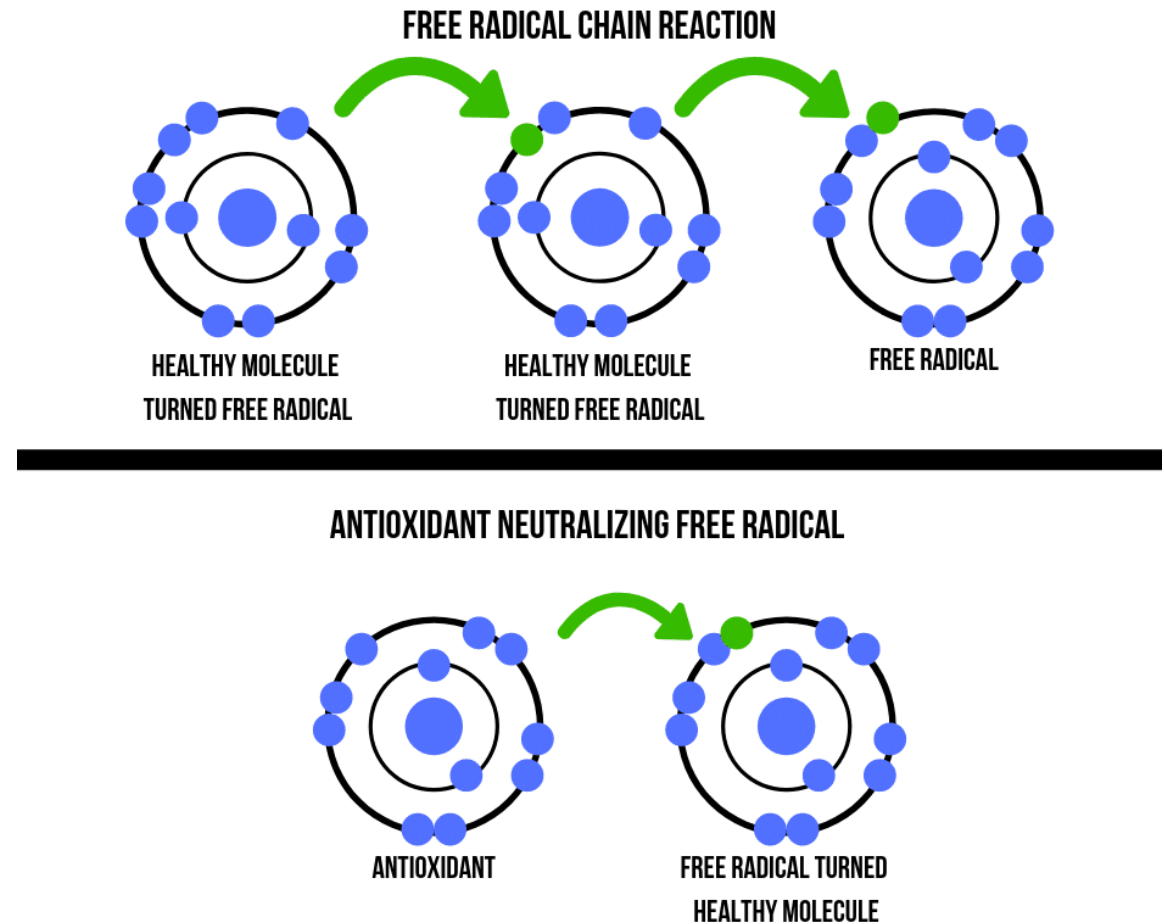


U.S. Organic Trade Association

Protective dietary additives

Antioxidants neutralize reactive oxygen species and other reactive free radicals, preventing cellular damage.

- **Electron Donation:** Antioxidants neutralize free radicals by donating an electron to them, preventing further cellular reaction.



Protective dietary additives

- **Flavonoids** in vegetables and fruits, especially in citrus, act as a potent antioxidants.
- **Polyphenols** in grapes, nuts, berries and many other foods is an antioxidant that protects tissues from DNA damage and apoptosis.
- **Sulforaphane** in green leafy vegetables is effective in preventing and treating various cancers.
- **Selenium** (Se) supplementation* protects cells from oxidative stress and reduces BPA-induced testicular damage.



SOURCES: Kuar et al., 2021; Ahmadi & Shadboorestan, 2015; Miyagi et al., 2000; Xiao et al., 2019; Nandini et al., 2020

*Speak with a healthcare provider before taking supplements; over supplementation can cause severe health problems.

Personal care and Fragrance

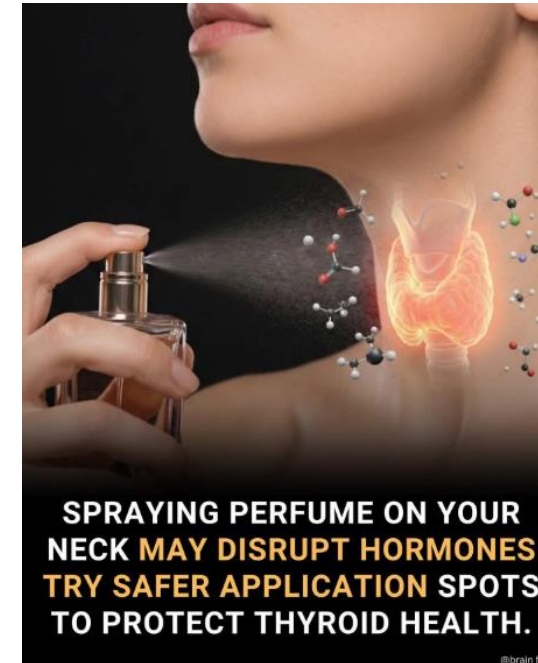
Personal care products such as lotions, soaps, and beauty supplies are a major source of EDC exposure.

- Synthetic fragrances can and often do contain **phthalates**.
 - Proprietary formulations are undisclosed, making consumer screening difficult.
 - 100% of perfumes tested in the EU contained phthalates at levels above regulatory levels.
- Anti-microbial additives such as **parabens** and **triclosan** increase shelf life / prevent clouding.

Al-Saleh & Elkhatab, 2015

Recommendation: Buy/produce fragrance-free products, “phthalate-free”, “paraben-free”.

Misinformation:



Absorption through skin is not well-established as a route of exposure, although it can occur.

Primary concern is *residues* on hands and contact with membranous tissues.

Chemical regulation

Endocrine-Disrupting Chemicals: Science and Policy

[Emily N Hilz](#)¹, [Andrea C Gore](#)¹

► Policy Insights Behav Brain Sci. Author manuscript; available in PMC: 2025 Jan 3.

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[10.1177/23727322231196794](https://doi.org/10.1177/23727322231196794) 

Toxic Substances Control Act



The U.S. EPA is the primary authority for chemical regulation in the United States

Manufacturers are responsible for safety testing chemicals before they are marketed, and for sharing that information with the EPA.

The *Toxic Substances Control Act* (TSCA; 2016) requires the EPA to conduct safety reviews of all new chemicals but has been criticized for substantial limitations such as:

- (1) grandfathering in known or suspected EDCs,
- (2) deviating from best-practices to assess chemical safety,
- (3) lacking data on the health effects of chemical mixtures,
- (4) limited resources and funding for regulatory agencies.

As of 2023, only 1 out of 60,000+ chemicals in commerce has received formal suggestions for regulation under the TSCA.

Regulatory Recommendations

Generally Recognized As Safe (GRAS) is an FDA designation that a food additive is considered safe.

Food manufacturers can declare an ingredient GRAS without notifying the FDA.

Reactionary regulation is not feasible.

Endocrine-Disrupting Chemicals: Science and Policy

[Emily N Hilz](#)¹, [Andrea C Gore](#)¹

► [Policy Insights Behav Brain Sci](#). Author manuscript; available in PMC: 2025 Jan 3.

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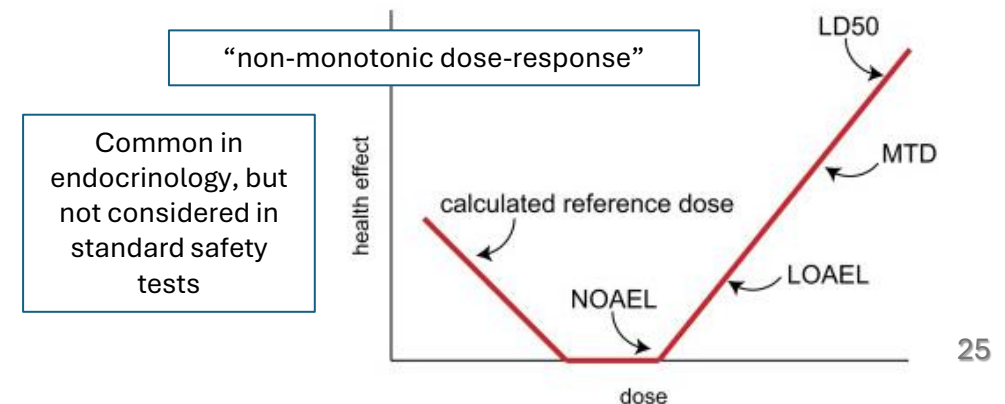
With regrettable substitutes, low-dose effects, thousands of “grandfathered” and “generally-recognized-as-safe” chemicals, and the synergetic effects of chemical mixtures, **science cannot keep up with chemical burdens** and **proactive regulation is necessary for meaningful change**.

Invest in green chemistry.

Restrict chemicals by *class*.

Advocate for science-backed screening and industrial transparency.

Thousands of studies demonstrate that EDCs cause harmful effects at doses below those designated safe.



Conclusion / Time for questions

Endocrine disruptors are present in manufactured plastics, foods, and products.
These chemicals are harmful to human health and lack regulation.

The primary health endpoints effected by EDCs include the **reproductive** system, **metabolism**, and **neurodevelopment**.

- Declining fertility rates, the obesity epidemic, and psychiatric disorders cost billions in healthcare.

EDCs are re-wiring the human body over time, and currently, the burden of addressing this primarily relies on consumers and manufacturers.

- Replacing plastics, investing in organics, and limiting unnecessary additives such fragrance.

Ultimately, regulatory action has been slow to materialize due to the complex science around endocrine disruption.

- Broad categorization, better screening practices, and green chemistry can improve human health.

Thank you!

Want to learn more about
endocrine disruptors and
how to avoid them?



endoscreen.org

GooglePlay App:

