Neuropsychiatric Effects of Plastics

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PLASTICS

Fossil fuel-derived hydrocarbon polymers
that imbue desired physical properties:
durability, color, oil, water repellency

Use:

1. **Packaging and single use (31%)**
2. **Buildings/Construction (17%)**
3. **Textiles (10%)**
4. **Consumer/institutional medical products (10-15%)**

1. Plastics contain

Plastics persist in environment and do NOT biodegrade

Tip

Fragments smaller than 5 mm = **microplastics**; smaller than 1 micron are **nanoplastics**

One study estimates that the ocean floor contains **14 million tons of microplastics**

Microplastic Inhalation over the Average Human Lifetime

If we think of microplastic inhalation as a visual height chart, over the course of these periods of time, the average human inhales the equivalent of...

Height of two giraffes
12.69 meters

Height of the Eiffel Tower
363 meters

Height of Snowdon Mountain, Wales
1,019 meters

Over a year

Over a lifetime (minimum)

Over a lifetime (maximum)

Imagery not drawn to scale.

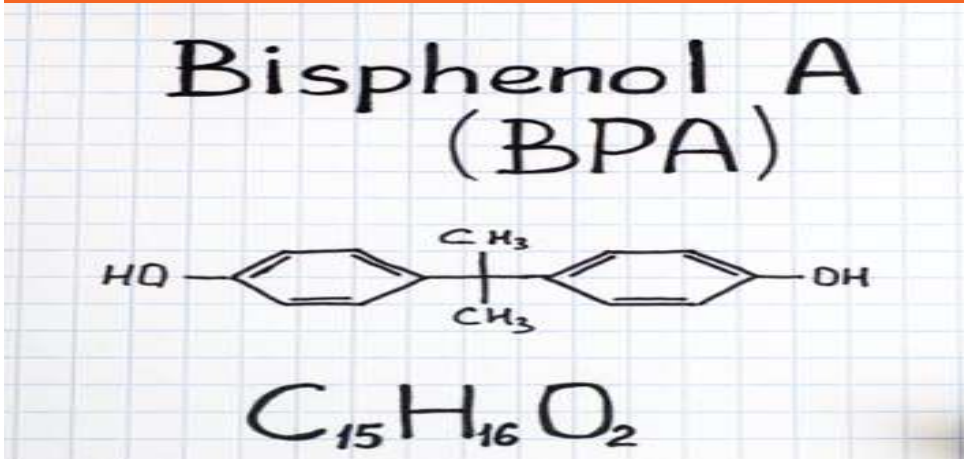
Neuropsychiatric Effects of BPA

1. Bisphenol-A: found in food and beverage containers associated w/ **anxiety and depression** in boys

- BPA can disrupt BBB making it potential environmental risk factor for **Alzheimer's disease**

BPA impairs neural proliferation, migration, and differentiation during brain development

- **Influences synaptic formation and activity in the brain**
- **Implicated in ADHD, and Schizophrenia**



Where are Phthalates hiding?

Shampoo, lotion, nail polish and other personal care products

Cosmetics

Scented products including air fresheners, perfumes and candles

Medical equipment

Building material, including vinyl flooring

Food containers

Backpacks and lunch boxes

Car interiors

Microplastics and the Brain

<u>Impact of microplastics on brain:</u>

1. **Crossing BBB**

- Accumulate in brain tissues, triggering inflammation and oxidative stress → neuronal damage

1. **Neuroinflammation**

- Chronic: AD, Parkinson's
- Proinflammatory cytokines

3. **Neurotoxic effects**

- **BPA and phthalates** may affect hormones, neurotransmitters, result in cognitive impairment, neurodevelopmental disorders

Further research essential to understand full extent of these effects on humans and mechanism by **which microplastics contribute** to neurodevelopmental disorders and/or neurodegeneration

Comparison of Different Plastics and their neuropsychiatric effects

Plastic Type (Additive)	Potential Neuropsych effect	Studies
BPA	Anxiety, depression, ADHD	X et al., Y et al.
Phthalates	Behavioral issues, Low IQ	A et al., B et al.
Microplastics	Cognitive decline, brain inflammation	Z et al., W et al.

Regulatory Status of Neurotoxic Plastics Worldwide

Country/Region	Ban on BPA	Ban on Phthalates	Microplastics Research
USA	Partial	Yes	Ongoing
EU	Yes	Yes	Extensive

Annual global plastics use has grown from 72 million tons in 1980 to 445 millions ton ins 2020 and its projected to double by 2040 and trib le by 2060

GROWING PROBLEM

Management at what stage:

1. Production Stage
2. Use stage
3. Disposal Stage

Solutions?

1. **Increasing recycling**
- Partial fix (many plastics can't be recycled)

1. Replace plastics w/ **eco-friendly alternatives** that are reusable or made from truly recyclable materials

3. **Break Free from Plastic Pollution Act**
- Introduced in Congress in 2020 and 2023 (not passed in either year)

BREAK FREE FROM PLASTIC POLLUTION ACT

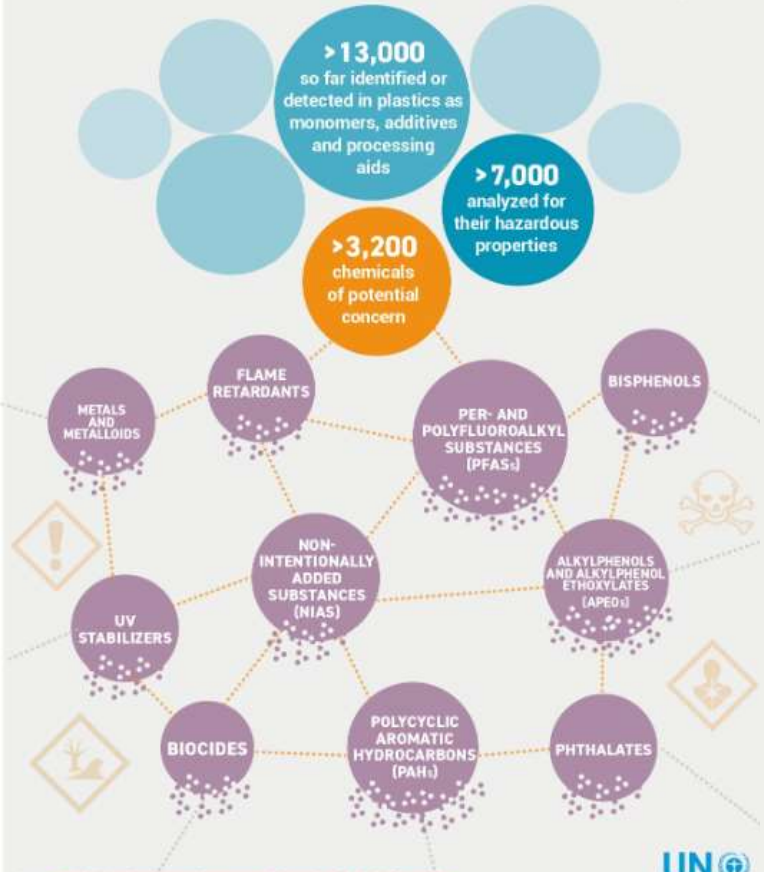
Specific features of ACT:

1. Reducing and banning certain **single-use plastic products** that are not recyclable

1. Establishing grant programs to support **reusable and refillable products**

1. Pressing pause on new plastic facilities until **critical environmental justice** and health protections are put in place

CHEMICALS OF CONCERN
IN YOUR PLASTICS



Source: United Nations Environment Programme and Secretariat of the Basel, Rotterdam and Stockholm Conventions (2023). **Chemicals in plastics: a technical report**. Geneva. and Aurisano et al. 2021; Wiesinger et al. 2021

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HUMAN EXPOSURE TO
CHEMICALS IN PLASTICS

SOURCES

EVERYDAY PLASTIC PRODUCTS, e.g. plastic-based food contact materials, building materials, electronics, textile, clothing and personal care and household products

CHILDREN'S products e.g. toys, clothing or furniture.

OCCUPATIONAL exposure at various stages of the plastic value chain

EXPOSURE PATHWAYS examples

- inhalation of contaminated air
- ingestion of contaminated food, water and dust
- dermal contact

ADVERSE HEALTH EFFECTS examples

- abnormal hormone functions
- reduced fertility
- damaged nervous system
- hypertension/ cardiovascular disease
- lung and liver cancer

Source: United Nations Environment Programme and Secretariat of the Basel, Rotterdam and Stockholm Conventions (2023). **Chemicals in plastics: a technical report**. Geneva.

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Plastic Effects on Health

Over time plastics break down into smaller and smaller pieces of hydrocarbon polymer w/ embedded chemicals

Tiny pieces readily disperse in the air, water, and soil; ubiquitous in environment

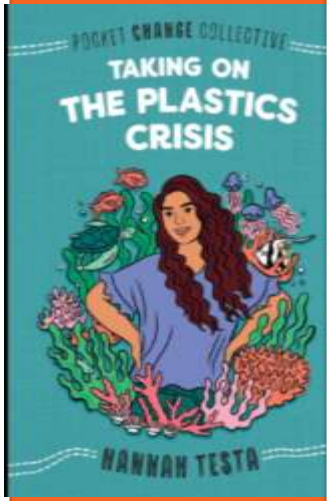
Endocrine disruption, Insulin resistance, neuropsychiatric complications, cancer, reproductive health issues

Plastics play an important role on human health

Plastics Crisis

Need for systemic change

1. **Reduce plastic production**
- Legislation
- Extended producer responsibility
1. **Increase recycling and reusability**
- Improve recycling infrastructure
- Deposit return schemes
1. **Promote Alternatives to plastics**
- Biodegradable materials
- Reusable products: cloth bags, metal straws



Support Circular Economy Models

- Plastics reused, remanufactured, and recycled in closed-loop system

Raise public awareness

- Education and advocacy

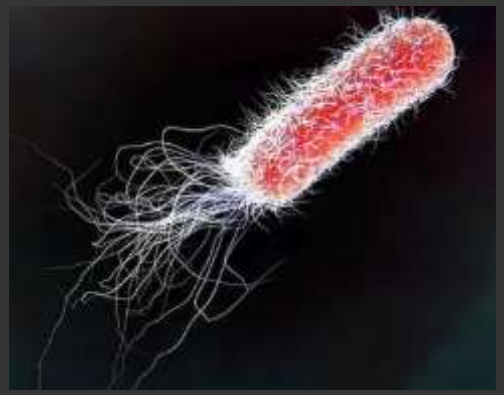
Innovative Solutions

- Technological advances: break down or recycle plastics more efficiently

Potential Solution to the Plastics Crisis!?!

Ideonella Sakaiensis

- **Bacterium that can digest PET, and certain phthalates**
- **PET commonly used in bottles as base components**



Researchers are developing enzymes such as PETase, that can accelerate plastic degradation

- **Holds great promise for breaking down hard-to-recycle plastics and reducing plastic pollution**

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