



Plastic and Health: an overview from the perspective of science

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Food
Packaging
Forum







But often solutions to plastic pollution do not address one important aspect:
chemicals

→ apart from plastic pollution and physical damage to marine life,

plastics also are an invisible danger because of their **hazardous chemical** composition

→ What do we know about chemicals and human health? Pete will show us.

Race for Water Foundation | 30 Nov 2020

KRAFT

Singles

American

no
artificial
flavors

24
SLICES

Excellent
source of
Calcium!

STERILIZED PREPARED CHEESE PRODUCT







Paradise, California
November, 2018
88 dead



A silhouette of the San Francisco skyline is visible against a hazy, orange-tinted sky. The Transamerica Pyramid is the most prominent building in the center. To the right, the Coit Tower is visible. A single bird is captured in flight in the center of the image. The foreground shows the dark silhouettes of buildings and trees on a hillside.

Environ Health Perspect. 2016 Oct;124(10):1651-1655. Epub 2016 May 13.








Urinary Concentrations of Bisphenol A and Phthalate Metabolites Measured during Pregnancy and Risk of Preeclampsia.

Cantonwine DE¹, Meeker JD, Ferguson KK, Mukherjee B, Hauser R, McElrath TF.


So this is our question...

What are the realities of
plastic toxicity?

There are thousands of different types of plastic

| | | | | | | |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
|  PETE |  HDPE |  PVC |  LDPE |  PP |  PS |  OTHER |
| Polyethylene Terephthalate | High-Density Polyethylene | Polyvinyl Chloride | Low-Density Polyethylene | Polypropylene | Polystyrene | Other |

Vinyl chloride



Styrene



Bisphenols and others



Different monomers

Even worse

It's not just the monomer

Additives to plastic

Non-intentionally added substances (NIAS)

A free pass for miracle plastics

Plastics seemed inert.

Worry about high doses.



© 1999 American Plastics Council



You could think of them as the sixth basic food group. Oh, you certainly wouldn't eat them, but plastic packaging does help pro-

help keep air out. While others let air in to help the food we eat stay fresher longer. Plastics also let you see what you're buying.

Plastics. An Important Part Of Your Healthy Diet.

tect our food in many ways. • To help lock in freshness, plastic wrap clings tightly to surfaces. To help lock out moisture, resealable containers provide a strong seal. And plastic wrap helps extend the shelf life of perishable produce, poultry, fish and meats. • To prevent spoilage and contamination, some varieties of plastics

taking the mystery out of shopping. All of which makes them versatile, durable, lightweight and shatter-resistant. • To learn more, call the American Plastics Council at 1.800.777.9500 for a free booklet. Plastics. One part of your diet you may never break.

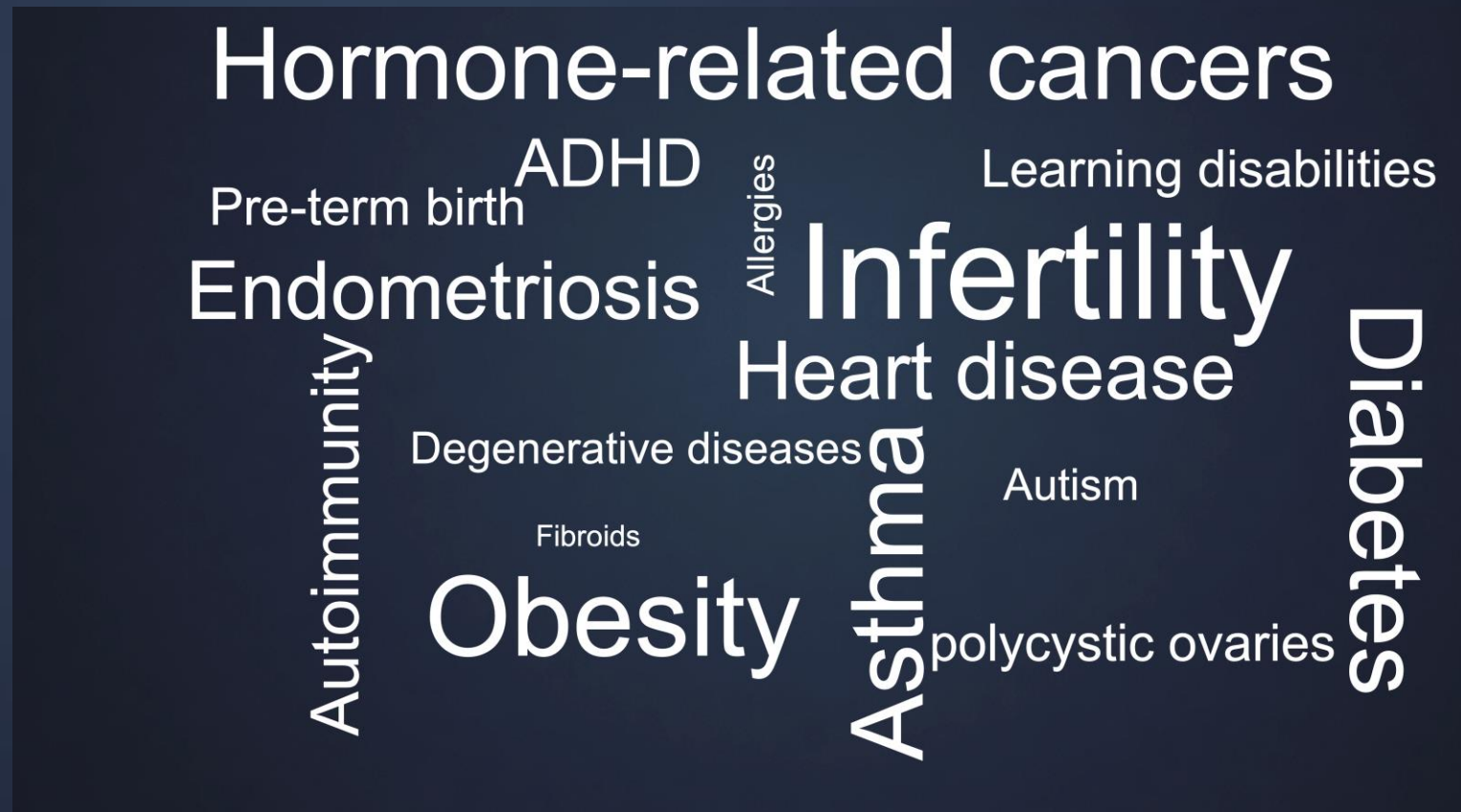


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New epidemics of chronic diseases appeared

many related to hormone dysfunction

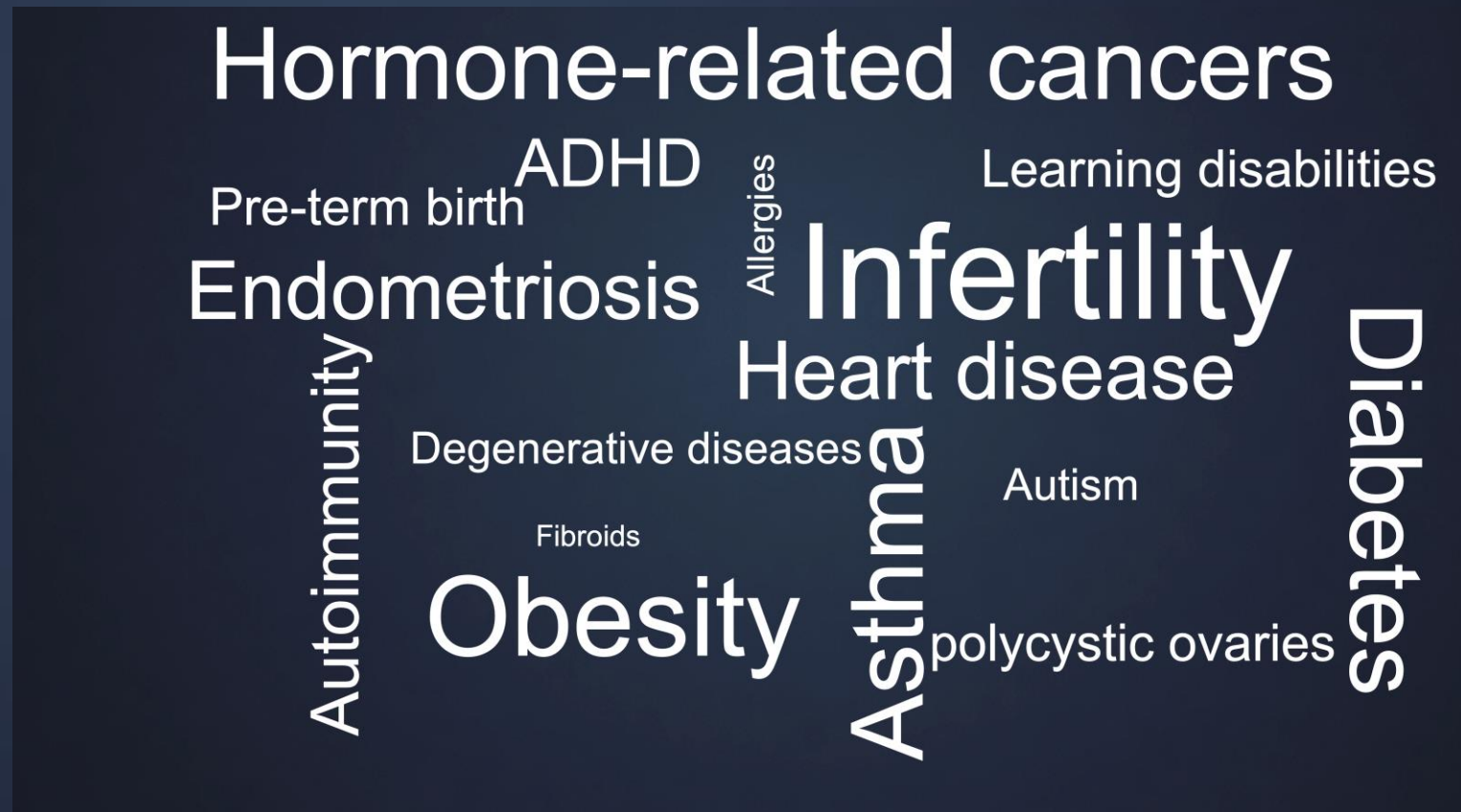


Chemists discovered our “body burden”

Plastic chemicals are inside us

The levels usually are low by standards of conventional toxicology

But scientists are demonstrating strong links
between plastic chemicals and the epidemics



Strong examples

Bisphenols (BPA + more)

Phthalates (DEHP + more)

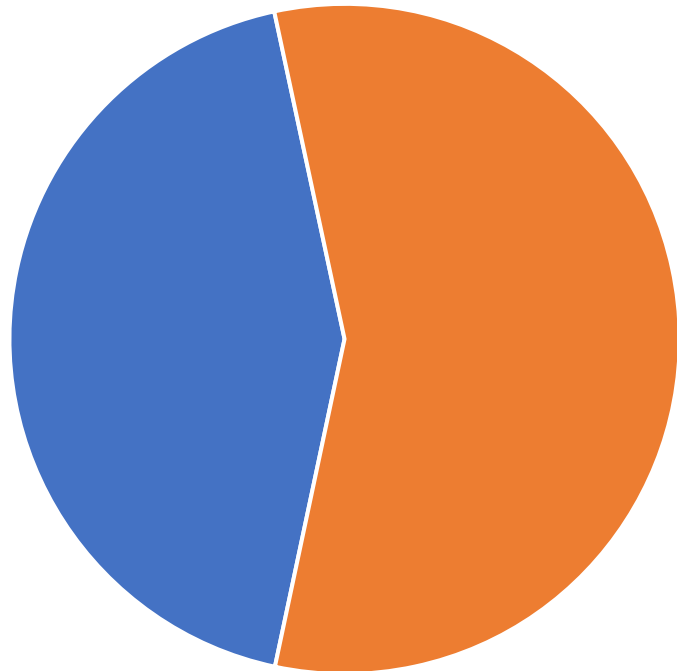
Perfluorinated chemicals (PFAS)

But....

How do these chemicals get from plastic into our bodies?

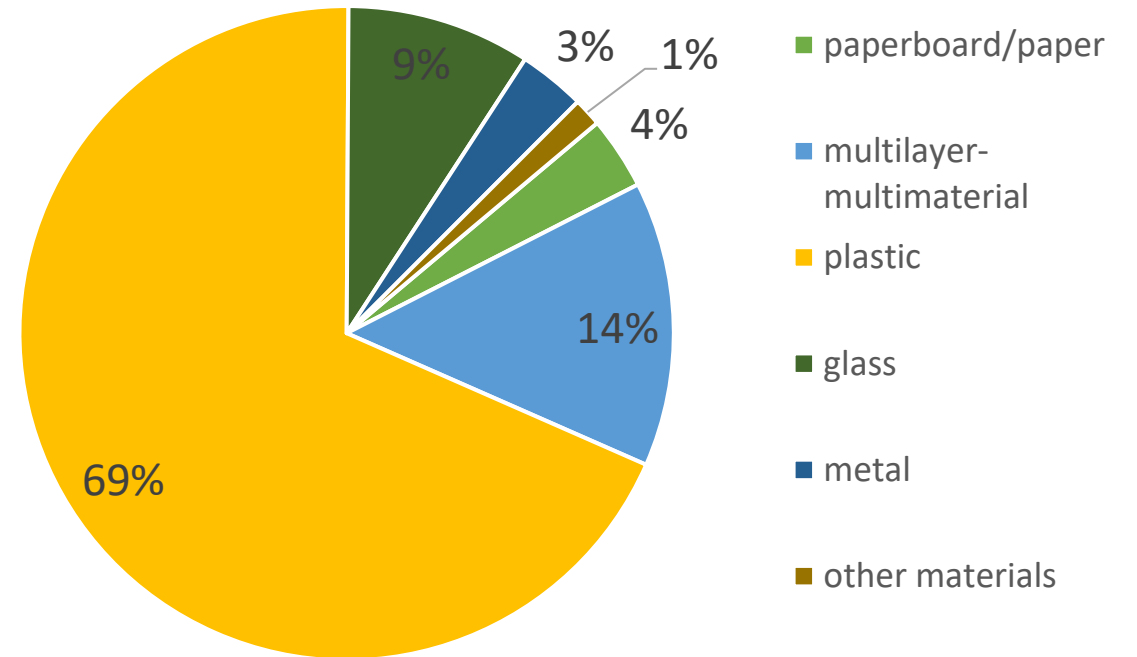
Jane?

Foodstuff packaged vs. unpackaged



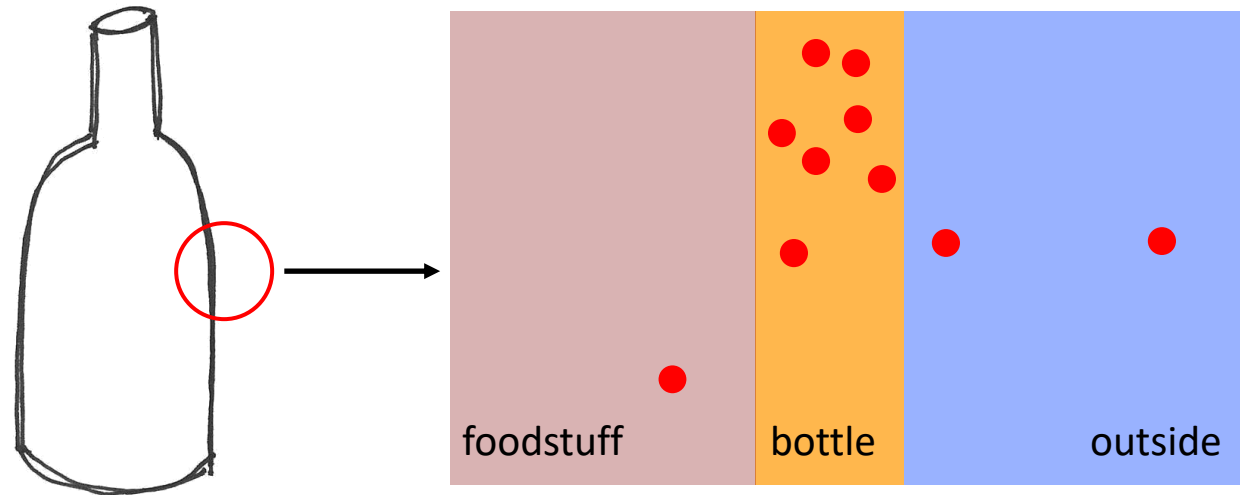
■ food items without package ■ food items with package

Food packaging type



Costa, S.A., Vilela, S., Correia, D., Severo, M., Lopes, C. and Torres, D. (2020), "Consumption of packaged foods by the Portuguese population: type of materials and its associated factors", *British Food Journal*. <https://www.emerald.com/insight/content/doi/10.1108/BFJ-07-2020-0584/full/html>

Migration of chemicals



heat higher temperature increases migration

time long storage time increases migration

food chemistry fatty foods, acidic foods, aqueous foods: **it depends on food stuff what chemicals migrate from the packaging**

packaging size smaller packaging has proportionally larger surface area, more migration per volume of food

levels in the packaging higher levels of a chemical in packaging can lead to higher migration



What chemicals are used to make food contact materials and articles?

1

Screening global regulatory and industry sources on food contact materials



2

Compiling the Food Contact Chemicals database (FCCdb) with 12'285 chemicals



3

Prioritizing 608 hazardous FCCs for substitution



“Overview of intentionally used food contact chemicals and their hazards.” Groh et al. 2020. Environment International. <https://www.sciencedirect.com/science/article/pii/S0160412020321802?via%3Dihub> (30 Nov 2020).
“Overview of known plastic packaging-associated chemicals and their hazards.” Groh et al. 2019. Science of the Total Environment. <https://www.sciencedirect.com/science/article/pii/S0048969718338828?via%3Dihub>

Toxic chemicals: 608 food contact chemicals most hazardous to human health and the environment

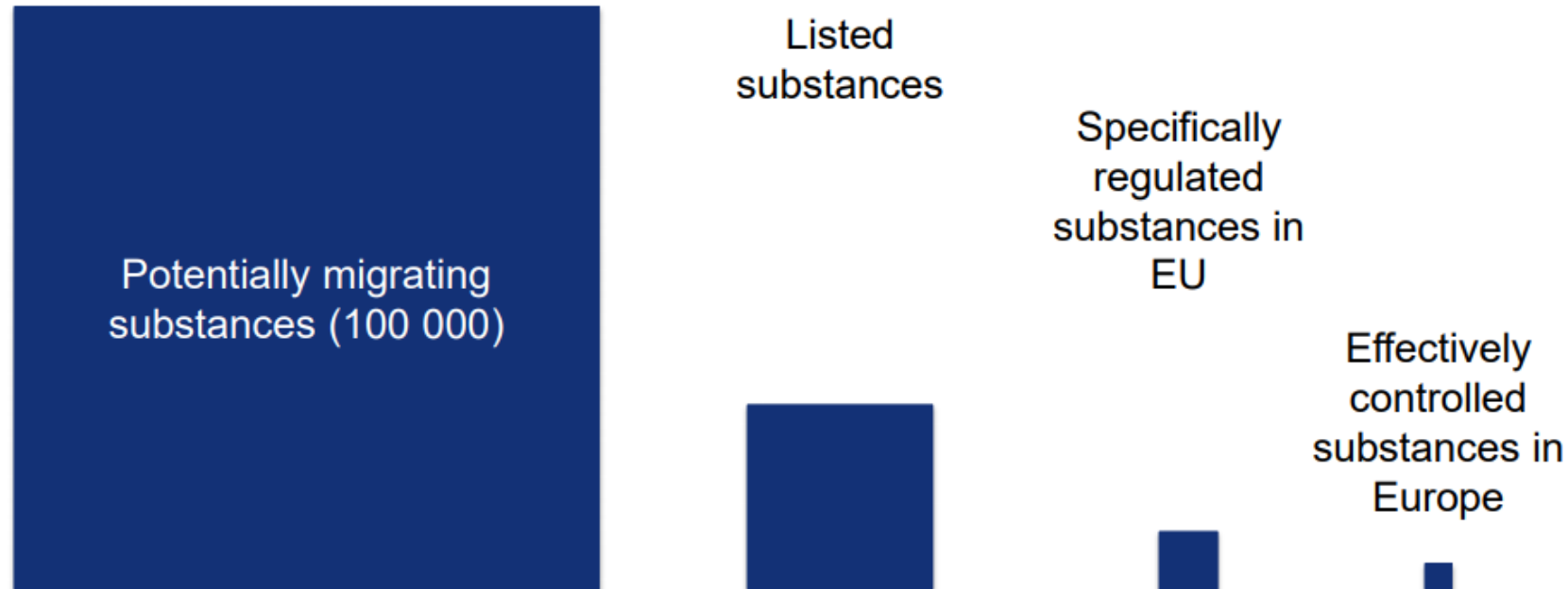


More information:
bit.ly/FPF_FCCdb
<http://bit.ly/fpf-fccdb>

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Migration of Food Contact Chemicals: *potential vs known*

(EU perspective, slide by Gregor McCombie)



Source & more: https://ec.europa.eu/food/sites/food/files/safety/docs/cs_fcm_eval-workshop_20180924_pres07.pdf
Grob et al. 2006 <https://www.ncbi.nlm.nih.gov/pubmed/16954061>

“SAFE”

no untested chemicals
and no hazardous chemicals

Legal definition of safety (EU 1935/2004, Art. 3.1.(a))

*Materials and articles, [...], shall be manufactured [...] so that, under normal or foreseeable conditions of use, they **do not transfer their constituents to food in quantities which could endanger human health***



low levels \neq safe levels

Pete will tell us why

Painful realizations

Most chemicals haven't been tested

The tests used are flawed and outdated

Core assumptions are wrong

Analyses manipulated to hide problems

Scientists started asking new questions!

Could 'low doses' be relevant?

What's a part per billion?

How many molecules?

2.65 trillion



BUT: What nobody really knew

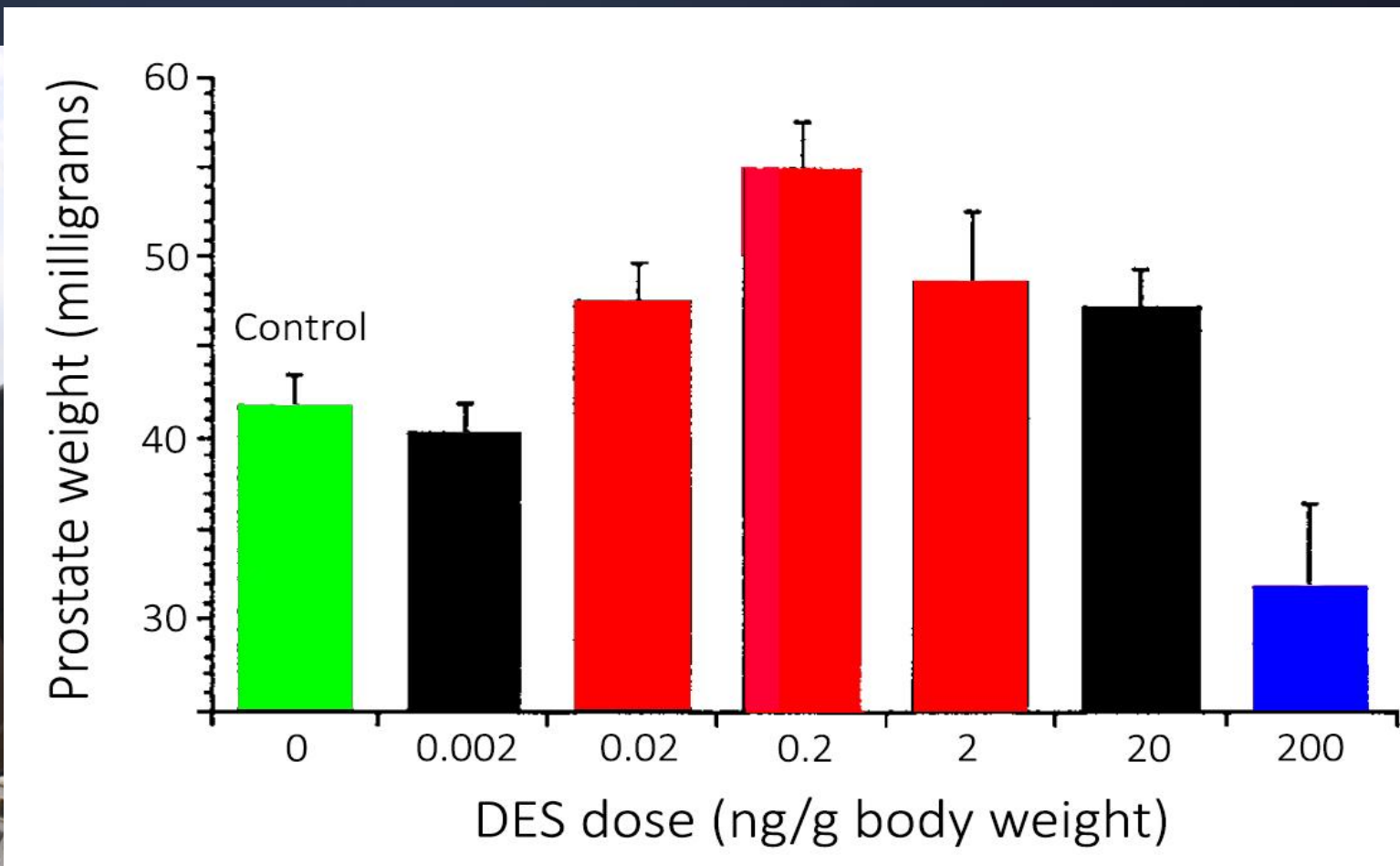


Hormones guide gene expression



EDCs hack the system

Epiphany



1 part per billion

What about 1000 ppb?



Same strain of mice
Same caloric intake
Same activity levels

Newbold *et al.* 2005, 2007

20,000



Not just the next generation...
multiple generations





But

What can be done?

What are the barriers to change?

Jane?



ใหม่
New

TESCO
อาหาร
สดใหม่
ทุกวัน

75
TGM แฮมรสชาต
TGM HAM SAUSAGE

97
TGM แฮมรสชาต
TGM HAM SAUSAGE

119
TGM แฮมรสชาต
TGM SMOKED PORK COCKTAIL

71
TGM แฮมรสชาต
TGM CERVELAT SAUSAGE 16

65
TGM แฮมรสชาต
TGM HAM SAUSAGE

65
TGM แฮมรสชาต
TGM HAM SAUSAGE

39
TGM แฮมรสชาต
TGM HAM SAUSAGE

52
TGM แฮมรสชาต
TGM HAM SAUSAGE

63
TGM แฮมรสชาต
TGM HAM SAUSAGE

71
TGM แฮมรสชาต
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77
TGM แฮมรสชาต
TGM HAM SAUSAGE

102
TGM แฮมรสชาต
TGM HAM SAUSAGE

39
TGM แฮมรสชาต
TGM HAM SAUSAGE

39
TGM แฮมรสชาต
TGM HAM SAUSAGE

49
TGM แฮมรสชาต
TGM HAM SAUSAGE

ลดราคา
Price off

ลดราคา
เดิม 74 บาท
59
S-P แฮมรสชาต
S-P ITALIAN SAUSAGE 16g

ลดราคา
เดิม 74 บาท
59
S-P แฮมรสชาต
S-P ITALIAN SAUSAGE 16g

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Shari Chankhamma @flickr.com

37

Kenta Hayashi @flickr.com

Enable
"experience"

Keep oxygen out:
preserve flavor

Keep CO₂ = "fizz" in

Keep pests out

Keep moisture out

Enable
traceability

Keep light out:
preserve vitamins
and taste

Food packaging functions

Enable
long term
storage

Convey
information to
consumer

Enable high-
throughput
production

Enable retail
selling

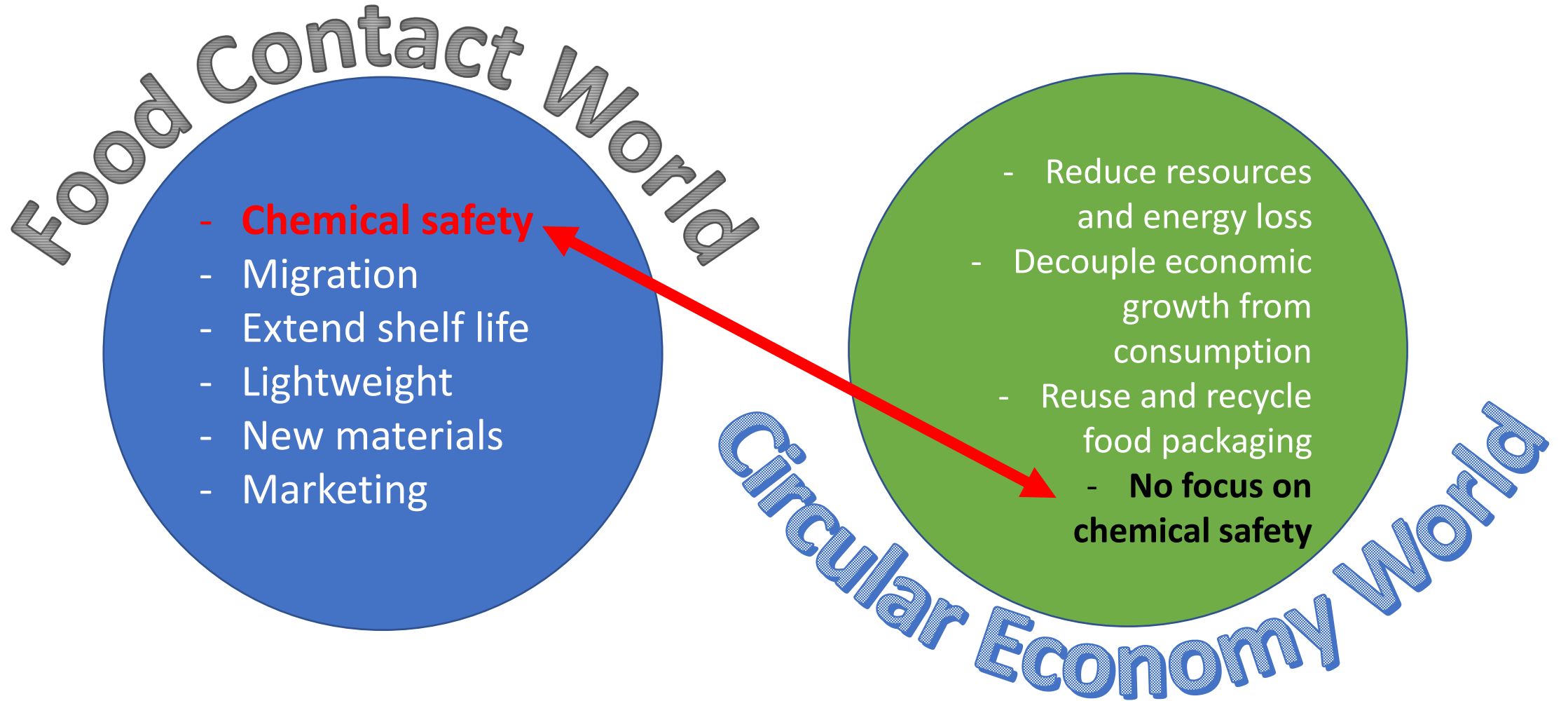
Advertise the
product

Prevent spoilage

Enable logistics
of complex
global supply
chains

Enable
convenience

Two disconnected worlds...



(Black) plastics made with recycled plastic



Source: A. Turner, 2018

Samsonek, J., and F. Puype 2013 Occurrence of brominated flame retardants in black thermo cups and selected kitchen utensils purchased on the European market. Food Additives & Contaminants: Part A 30(11):1976-1986.

<https://www.tandfonline.com/doi/abs/10.1080/19440049.2013.829246>

Rani, Manviri, et al. 2014 Hexabromocyclododecane in polystyrene based consumer products: An evidence of unregulated use. Chemosphere 110:111-119.

<https://www.sciencedirect.com/science/article/pii/S0045653514002252?via%3Dihub>

Turner, Andrew 2018 Black plastics: Linear and circular economies, hazardous additives and marine pollution. Environment International 117:308-318.

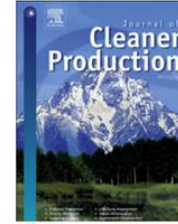
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Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



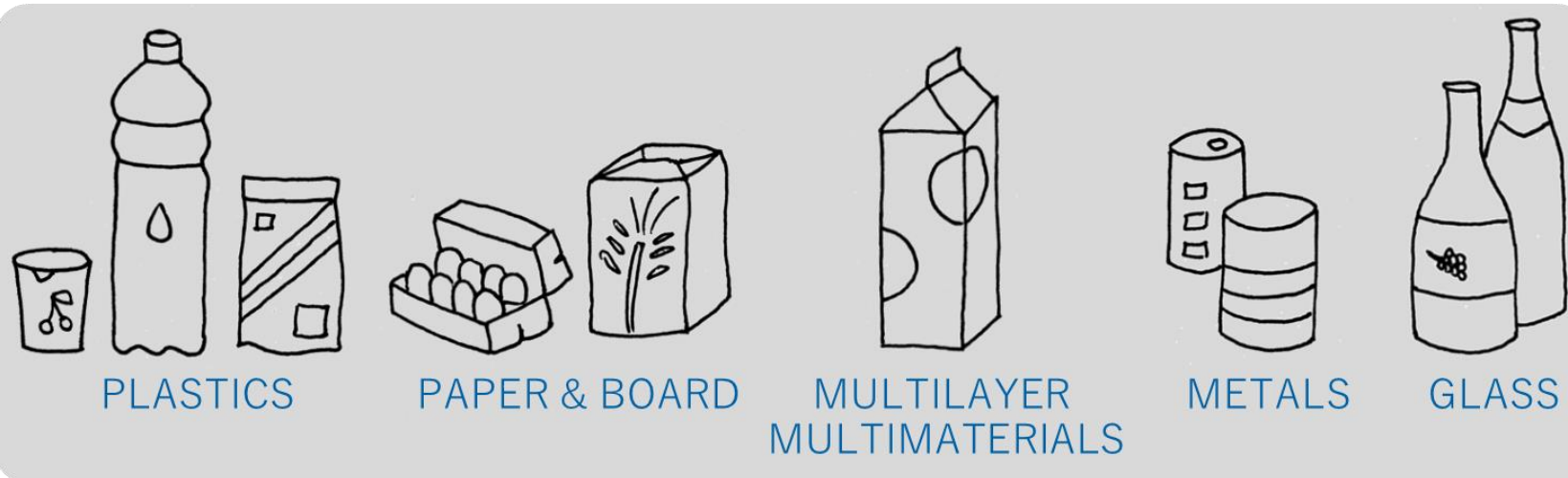
Review

Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials



Birgit Geueke*, Ksenia Groh, Jane Muncke

Food Packaging Forum Foundation, Staffelstrasse 8, 8045 Zurich, Switzerland



<https://www.sciencedirect.com/science/article/pii/S0959652618313325>

- MANY examples for different materials where recycling leads to accumulation of HAZARDOUS CHEMICALS!!!
- Reuse is also of concern for non-permanent materials: paper and plastic can absorb chemicals



Way forward

Regulatory change:

- EU Chemical Strategy for Sustainability requires testing for EDCs in food contact materials
- mixture toxicity needs to be addressed in EU
- EU FCM regulatory overhaul by 2022
- US: citizen petition on cumulative exposure <https://www.foodpackagingforum.org/news/petition-calls-for-us-fda-to-consider-cumulative-effects>

Stakeholder initiatives:

- FSAP list (March 2019) <https://www.iopp.org/i4a/pages/index.cfm?pageID=2264>
- EDF list <https://supplychain.edf.org/resources/key-chemicals-of-concern-in-food-packaging-and-food-handling-equipment/>
- Scorecard: google-initiated collaboration between food service providers, scientists and NGOs <https://youtu.be/Zkg3sN1Ylyg>
- Discuss EDCs and other hazardous chemicals in food packaging in context of SUSTAINABLE food production and consumption



some plastic uses
are essential*

*concept of ESSENTIAL USE: Cousins et al. 2019

<https://pubs.rsc.org/en/content/articlelanding/2019/EM/C9EM00163H#ldivAbstract>

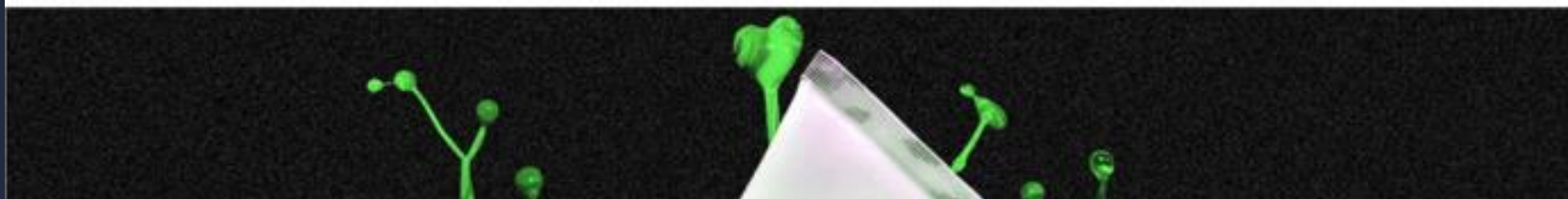


for essential uses of plastics: how can
we improve the chemistry?

Pete will tell us

09.18.19

Three-quarters of plastic products are toxic



ENVIRONMENTAL
Science & Technology

DOI: 10.1021/acs.est.9b02293

Article

pubs.acs.org/est

Benchmarking the in Vitro Toxicity and Chemical Composition of Plastic Consumer Products

Lisa Zimmermann,^{*,†} Georg Dierkes,[‡] Thomas A. Ternes,[‡] Carolin Völker,[§]
and Martin Wagner^{†,||}

If you don't test, you don't know.

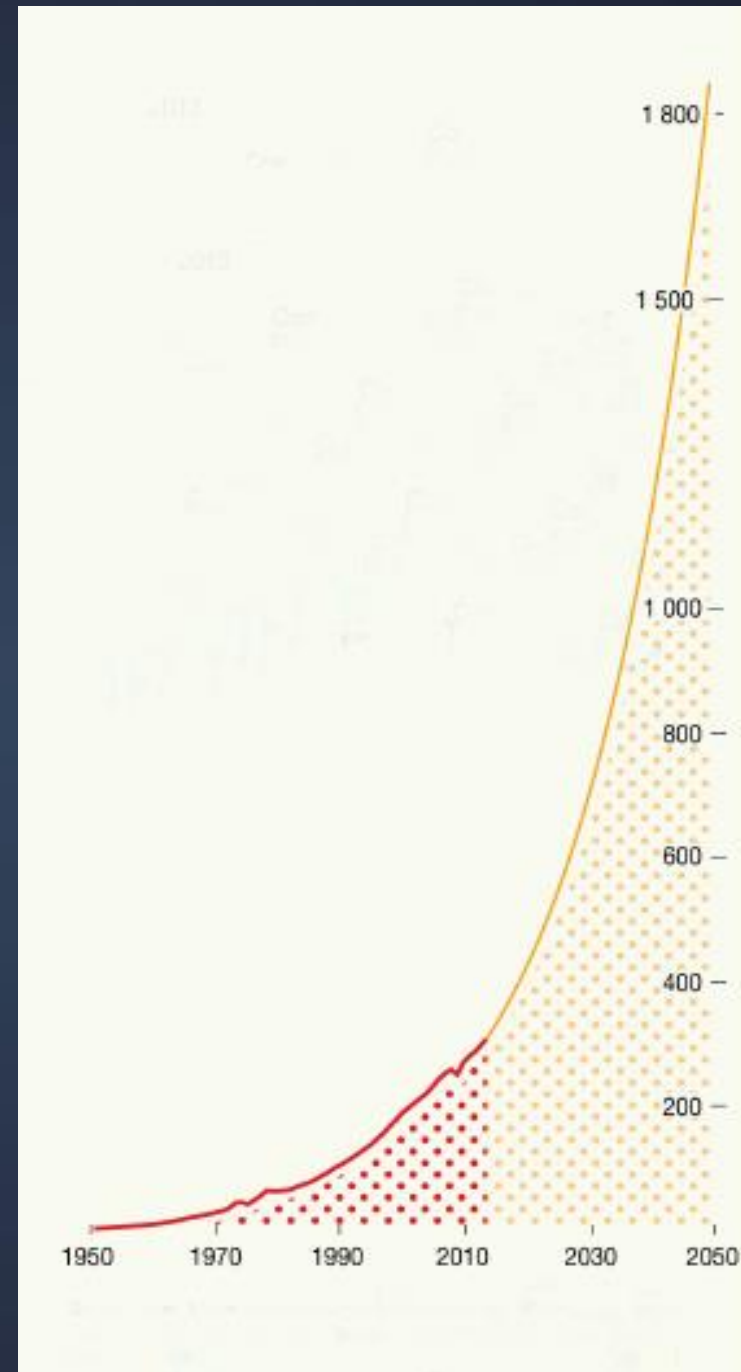
Computational tests aren't ready for prime time

Assumptions like “thresholds of toxicological concern” are simplistic, dangerous hand-waving.

Bio-based plastics can be toxic, too.

If you don't use 21st century science to test, you don't know.

Global plastic production millions of tonnes







Redesign

A new
day

Reform

Recharge

Designing endocrine disruption out

T. T. Schug,^{*a} R. Abagyan,^b B. Blumberg,^c T. J. C
T. M. Edwards,^h A. C. Gore,ⁱ L. J. Guillette,^j T. H
K. A. Thayer,^o L. N. Vandenberg,^p J. C. Warner,^q
K. P. O'Brien^{*g} and J. P. Myers^{*u}

Received 12th January 2012, Accepted 4th September 2012
DOI: 10.1039/c2gc35055f



A new voluntary testing protocol to aid chemists in the design of safer materials. Created by scientists, for scientists, TiPED is a dynamic tool to facilitate efficient and early identification of potentially problematic chemicals.

[Home](#) | [Guiding Principles](#) | [TiPED Overview](#) | [Tier 1](#) | [Tier 2](#) | [Tier 3](#) | [Tier 4](#) | [Tier 5](#) | [Resources](#) | [About](#) | [Users Group](#)

- 1 Computation Based Assessments
- 2 High-Throughput *In vitro* Screening (HTS)
- 3 *In vitro* Whole Cell Activity Assessment
- 4 Fish and Amphibian Assessment
- 5 Mammalian Assessment

Conclusions

1. Plastic production is increasing globally, and so is plastic pollution
2. Non-plastic alternatives are not necessarily safer in terms of chemicals
3. Chemicals migrate from packaging – plastic and non-plastics – into food and the environment, mostly at low levels.
4. Low levels of hazardous chemicals are not automatically safe: they matter, and mixtures of chemicals, and timing of exposure also matter.
5. Solutions to the plastics pollution crisis must be systemic and must address root causes.
6. Importantly, solutions will also adequately address hazardous chemicals in any alternative materials.
7. Chemicals need to be tested appropriately for their intrinsic hazards.

<http://bit.ly/plasticene>



Into the Plasticene

Tracking the global growth in plastic pollution

This newsletter is sponsored by



plasticpollutioncoalition

refuse single-use plastic



Plastics: the new coal in Appalachia?

insideclimatenews.org | Feb. 25

With the natural gas fracking boom, plastics production is spreading in the Ohio River Valley. But at what cost to health and climate?



Maine could be among first in U.S. to ban plastic bags statewide

pressherald.com | Feb. 24

With 20 communities already restricting them, and more on the way, the state may take California's environmental cue.



Draft UK law seeks to create committee on plastic pollution

businessgreen.com | Feb. 24

Food Packaging Forum (FPF) Foundation



Science communication & scientific research (desk-based)



Food contact materials, chemicals, migration, human health



2012 in Zurich



Scientists & science communication experts



Donations and project-based funding



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