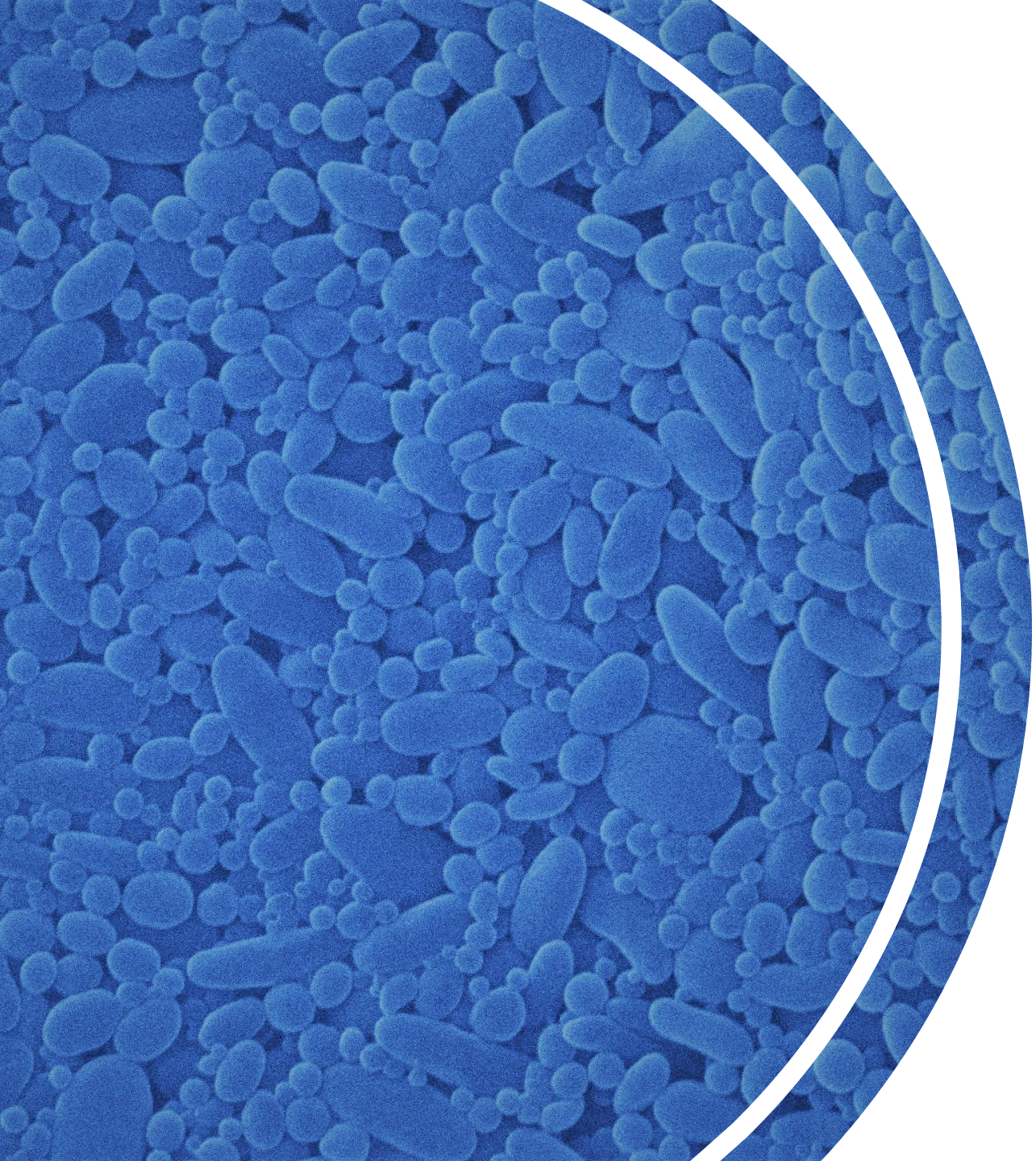


IMPACT OF MICROPLASTICS ON HUMAN HEALTH

Rob Ellis-Hutchings, Ph.D., DABT

Toxicologist - Dow, Inc.

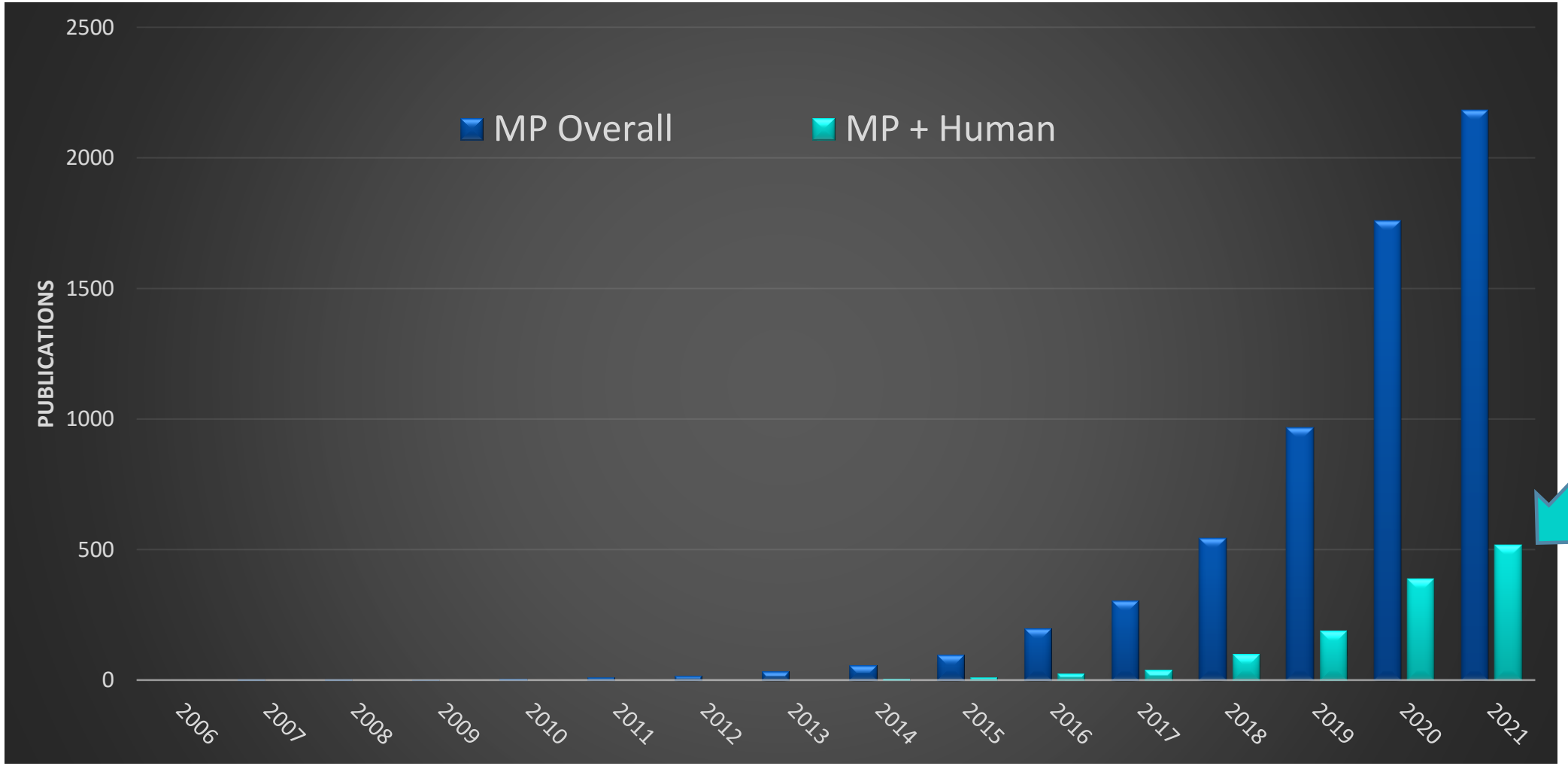
NAS Food Forum Microplastics Webinar

December 8, 2021

DISCLOSURE

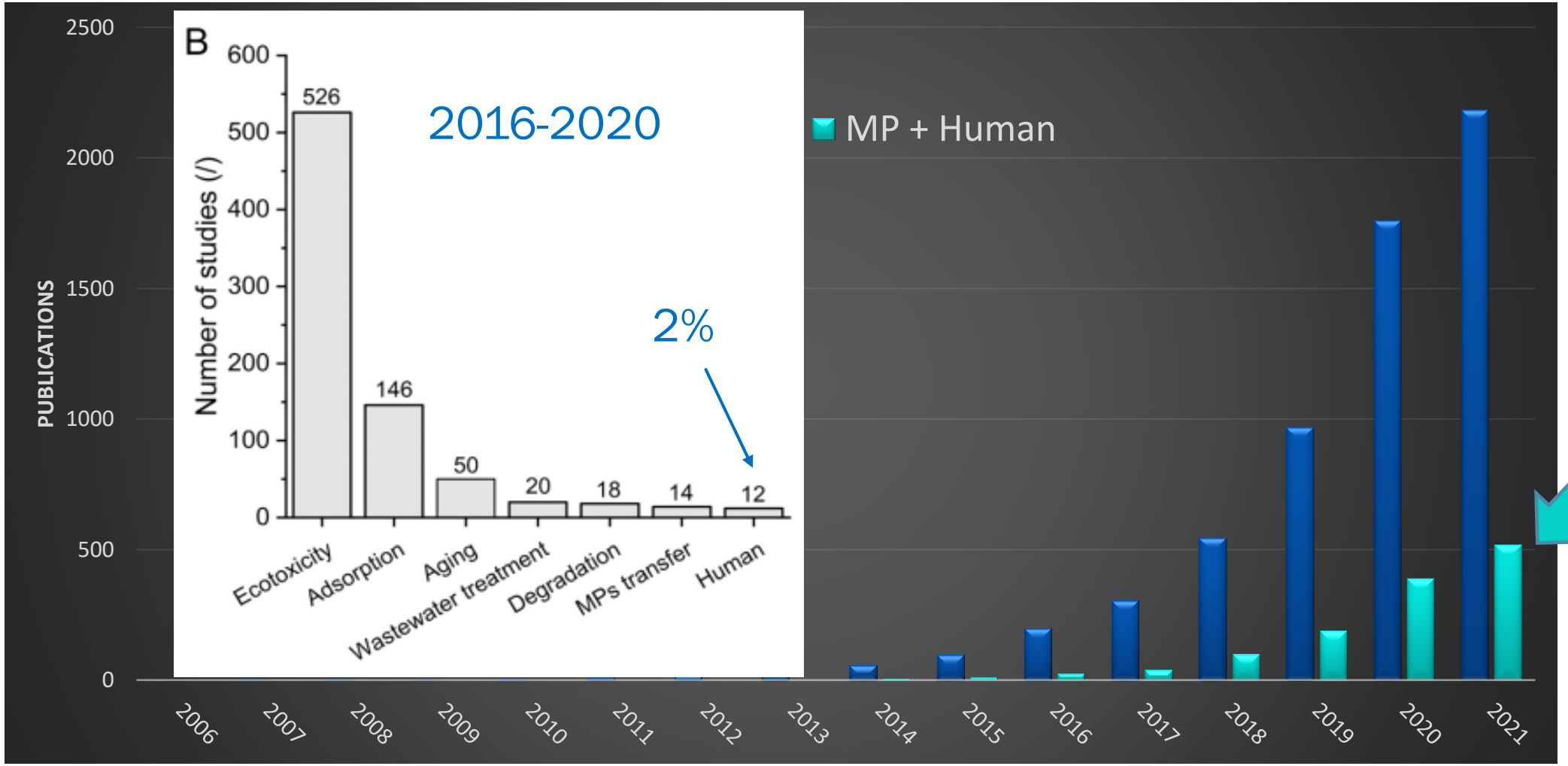
Rob Ellis-Hutchings works for Dow, which produces a variety of materials including plastics.

Proliferation of Microplastics Science



>75% Reviews & Env. Monitoring

Proliferation of Microplastics Science



>75% Reviews & Env. Monitoring

Rozman and Kalcikova, 2022

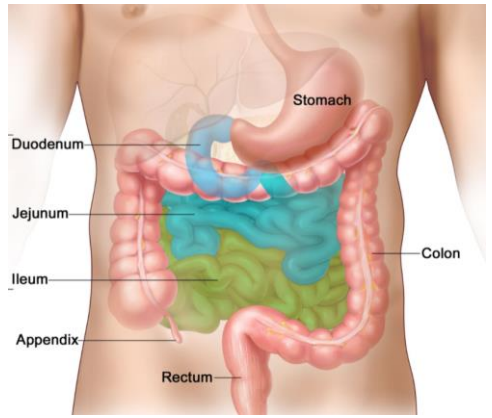
Where Is the Science Being Conducted?

ETC.

What is the impact of Microplastics on Human Health?

What is the actual exposure via foods & drinks?

Absorption, Distribution, Excretion?



External Exposure

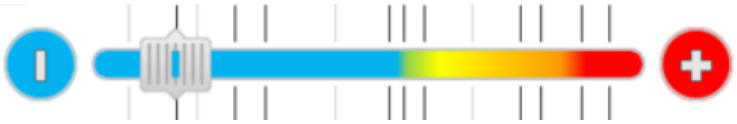
Internal Exposure

?

Risk of Adverse Effect

Adverse (Hazard) Effect

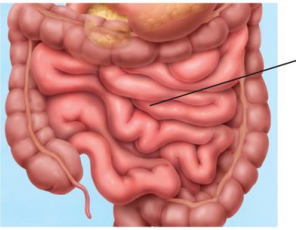
Relationship between adverse effect & exposure?

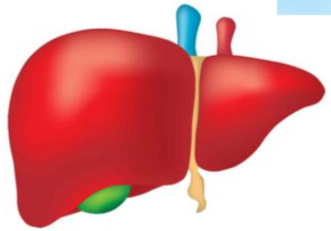


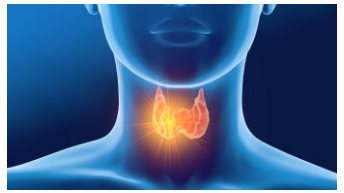
Exposure

Adverse Effects

Health Effects?







What is the impact of Microplastics on Human Health?

What is the actual exposure via foods & drinks?

External Exposure

Internal Exposure

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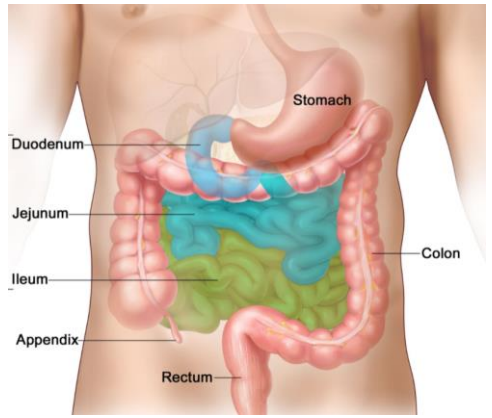
Absorption, Distribution, Excretion?



Relationship between adverse effect & exposure?

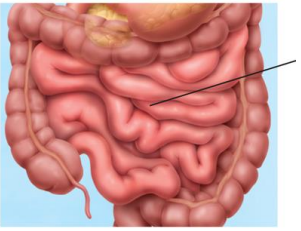
Exposure

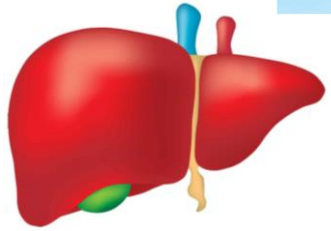
Adverse Effects

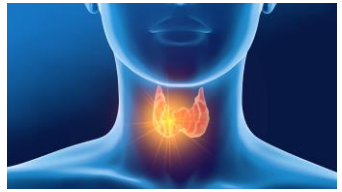
Risk of Adverse Effect

Adverse (Hazard) Effect

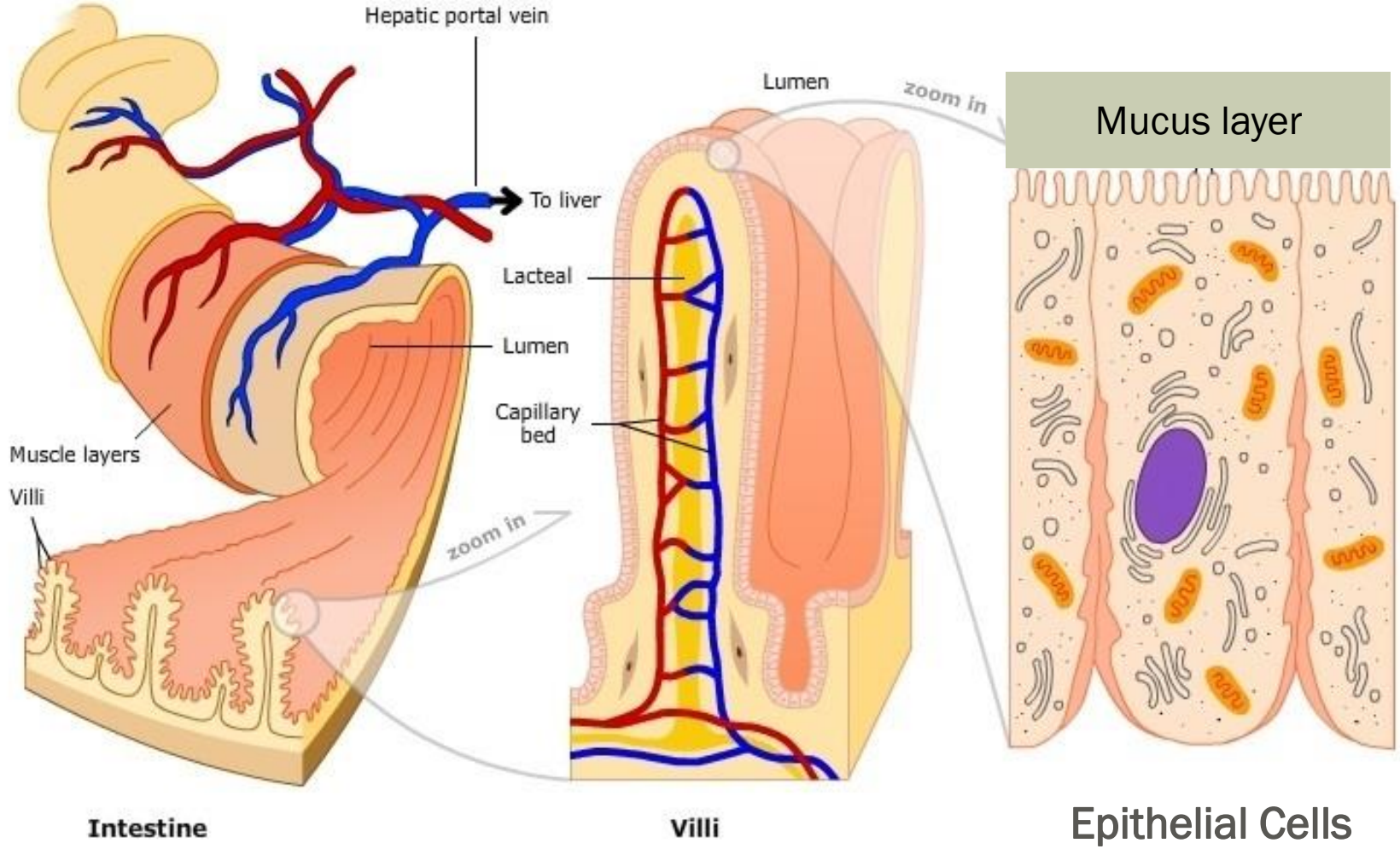
Health Effects?



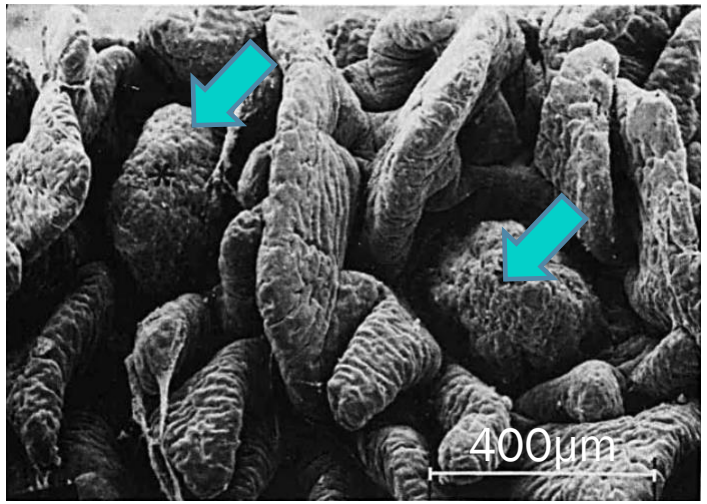




Internal Exposure – Small Intestine



Peyer's patches w/ Microfold (M) Cells

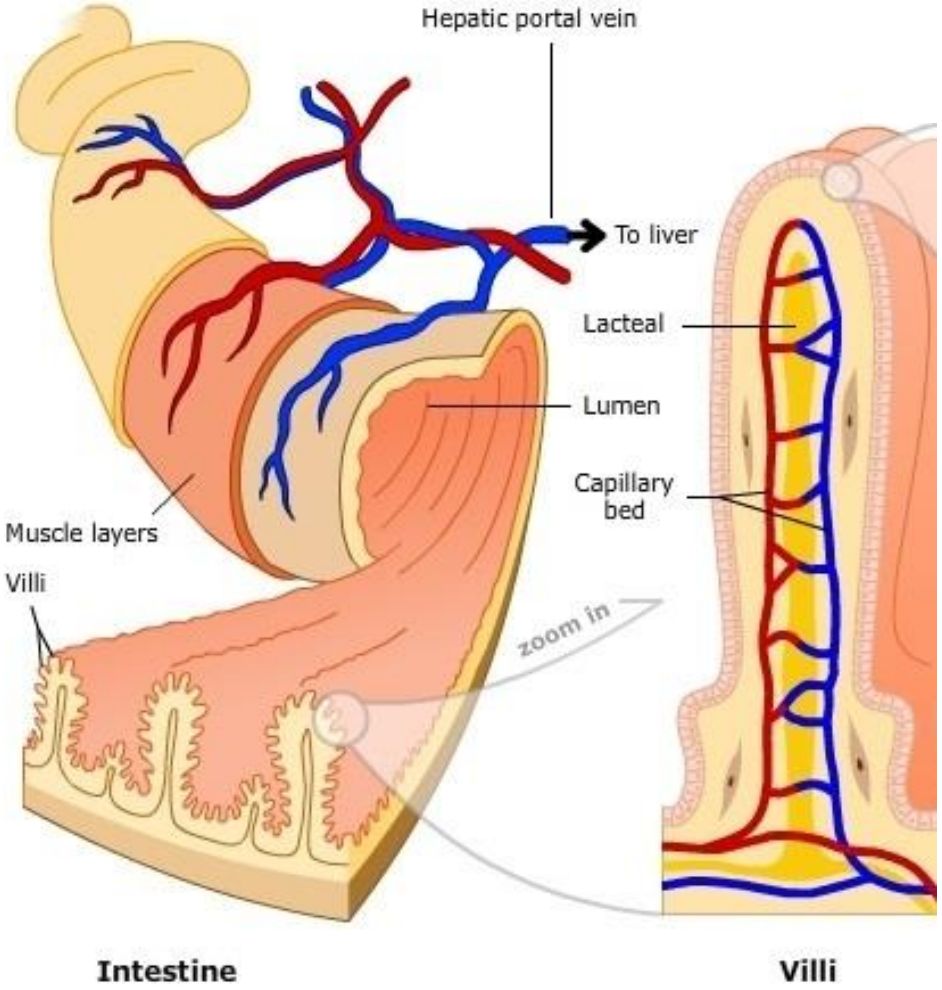


Lymphoid tissue

Vellengat et al., 1985

General Uptake Limits – Particle Size*

* Based on limited available animal model and *in vitro* data



European Food Safety Agency
<1.5µm can penetrate GI barrier

Epithelial Cell Uptake = 0.13% to 1%
- 1-2 µm particle

≥ 99% Not absorbed → Excreted

Carr et al. (2012); Desai et al. (1996, 1997); Eldridge et al. (1989); Florence et al. (1995); Jani et al. (1990, 1996); LeFevre et al. (1980);McClean et al. (1997); Reineke et al. (2013); Stock et al. (2019)

General Uptake Limits – Particle Size*

* Based on limited available animal model and *in vitro* data

Modulating factors

- Surface properties (charge, hydrophilicity, corona, chemical modifications, etc.)
- Shape
- Diet & lifestyle
- Pregnancy/lactation

European Food Safety Agency
<1.5µm can penetrate GI barrier

Epithelial Cell Uptake = 0.13% to 1%
- 1-2 µm particle

≥ 99% Not absorbed ⟶ Excreted

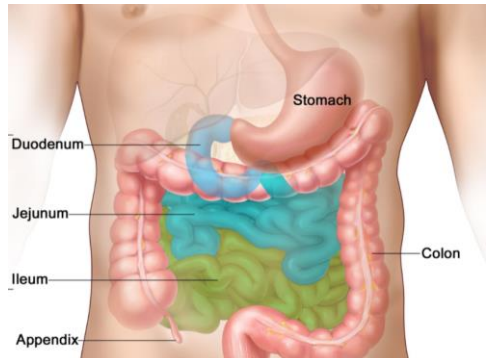
Carr et al. (2012); Desai et al. (1996, 1997); Eldridge et al. (1989); Florence et al. (1995); Jani et al. (1990, 1996); LeFevre et al. (1980);McClean et al. (1997); Reineke et al. (2013); Stock et al. (2019)

Modeled Steady State Microplastics – GI Tract (Nur et al., 2021)

What is the true exposure via foods & drinks?

External Exposure → Internal Exposure

Absorption, Distribution, Excretion



0.3% intestinal uptake

Median abundances*

- Children: ≈ 300 particles
- Adults: ≈ 500 particles

* Expected to be a low estimate

MICROPLASTICS - HUMAN HEALTH HAZARDS

EFSA - 2016

STATEMENT

EFSA Journal

ADOPTED: 11 May 2016

doi: 10.2903/j.efsa.2016.4501

Presence of microplastics and nanoplastics in food, with particular focus on seafood

EFSA Panel on Contaminants in the Food Chain (CONTAM)

BfR - 2018

www.bfr.bund.de

BfR

Bundesinstitut für Risikobewertung

Is there a risk to human health from microplastics? More research and scientific data needed

BfR Communication No 033/2018 of 29.10.2018

WHO – 2019

Studies quality scored

Microplastics in drinking-

World Health Organization

Science assessment of plastic pollution

Environment and Climate Change Canada

Health Canada

October 2020

ECCC - 2020

Micro- and nanoplastics – current state of knowledge with the focus on oral uptake and toxicity

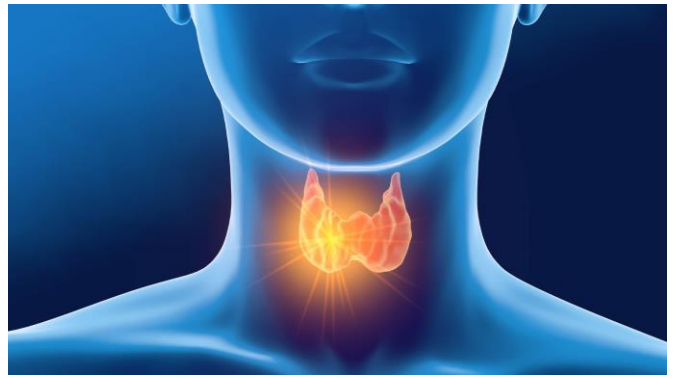
Maxi B. Paul,[a] Valerie Stock,[a] Julia Cara-Carmona,[a] Elisa Lisicki,[a] Sofiya Shopova,[a] Valérie Fessard,[b] Albert Braeuning,[a] Holger Sieg *[a] and Linda Böhmert[a]

BfR & ANSES - 2021

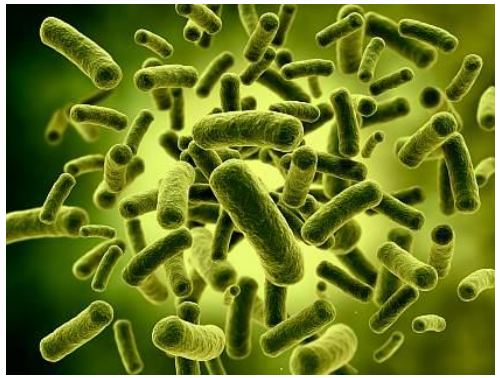
Do Microplastics Cause Adverse Effects?

No effects

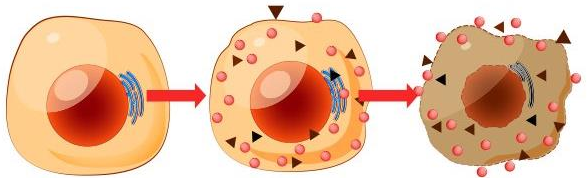
Thyroid



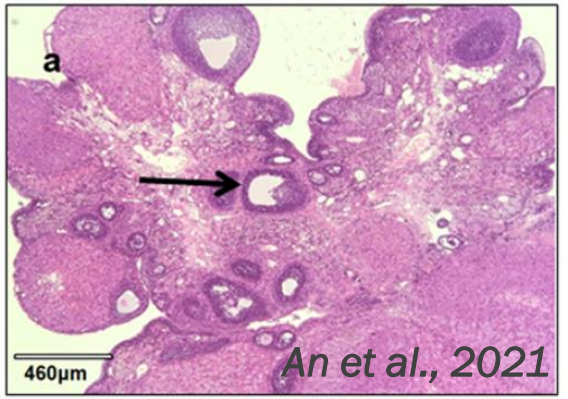
Microbiome



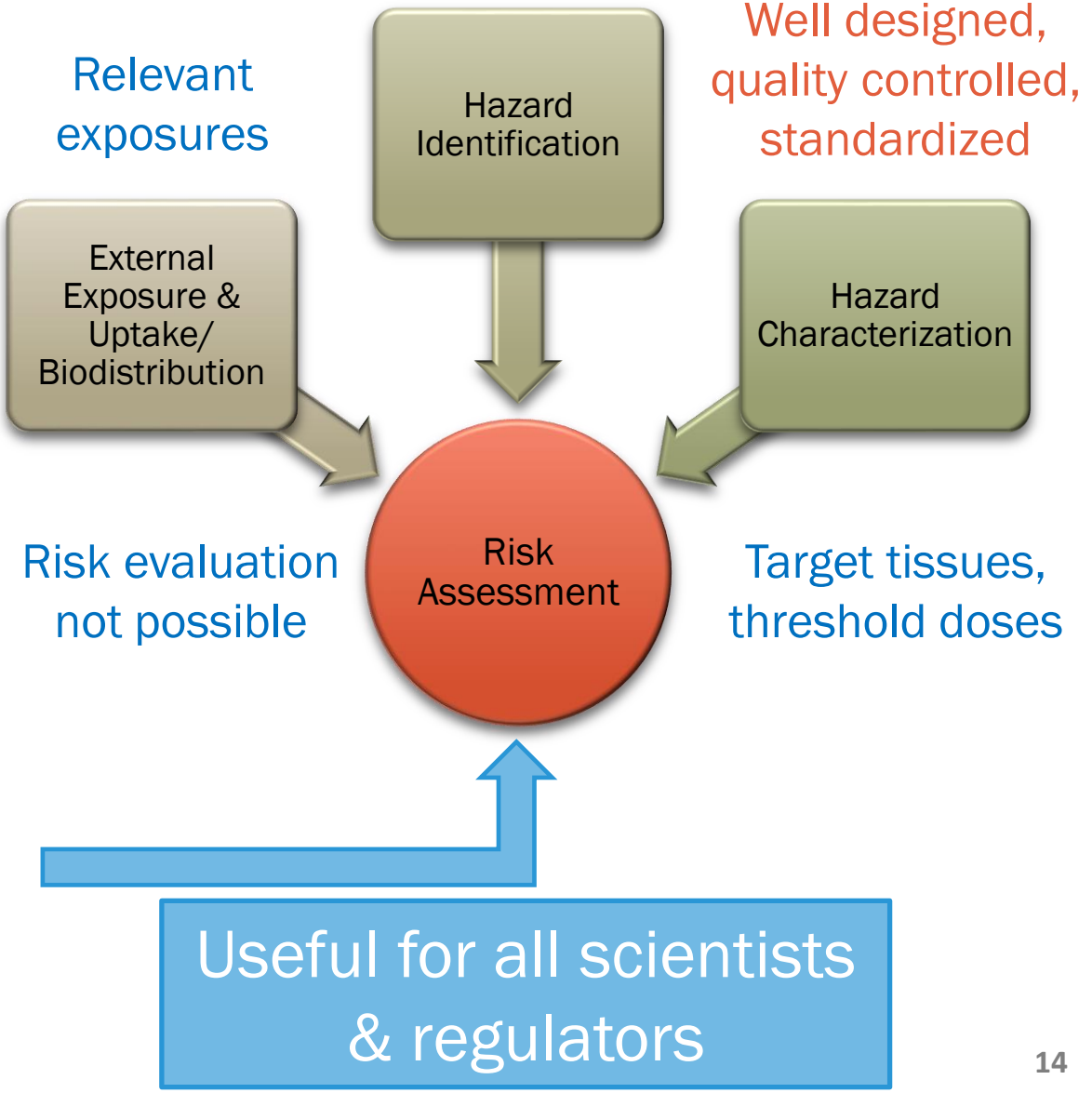
Oxidative Stress & Inflammation



Female & Male Reproductive Toxicity

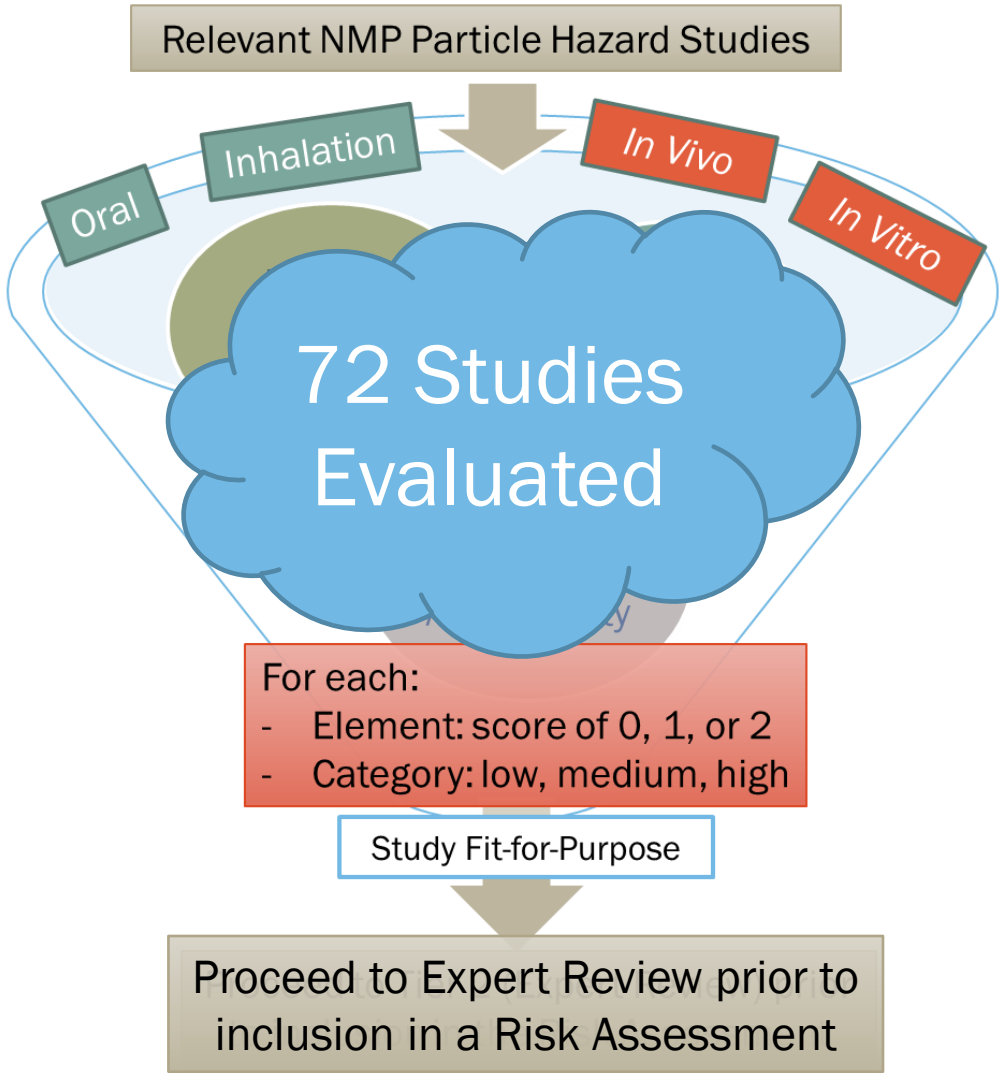


Conclusions from Authority Assessments



Development of a Screening Tool for Nano/Microplastic Human Health Hazard Studies

- Aim: Initial screen of hazard studies for use prior to human health risk assessments
  - ✓ Transparent
  - ✓ Relevance, reliability
  - ✓ Criteria: Particle characteristics, Experimental design, Applicability to risk assessment
- Incorporates screening elements from:
  - ✓ ToxRTool (Human health – not MP)
  - ✓ de Ruitjer et al., 2020 (Env. MP)



Gouin T, Ellis-Hutchings R, Hampton LT, Lemieux C, Wright S (minor revisions). Microplastics and Nanoplastics

Key Observation 1: Current Microplastic Test Materials Are Not Representative

Typical Microplastic Test Material

- Polystyrene reference material (~90%)
- Limited/no composition information

≠

Secondary Microplastics from Food Contact Polymer Products

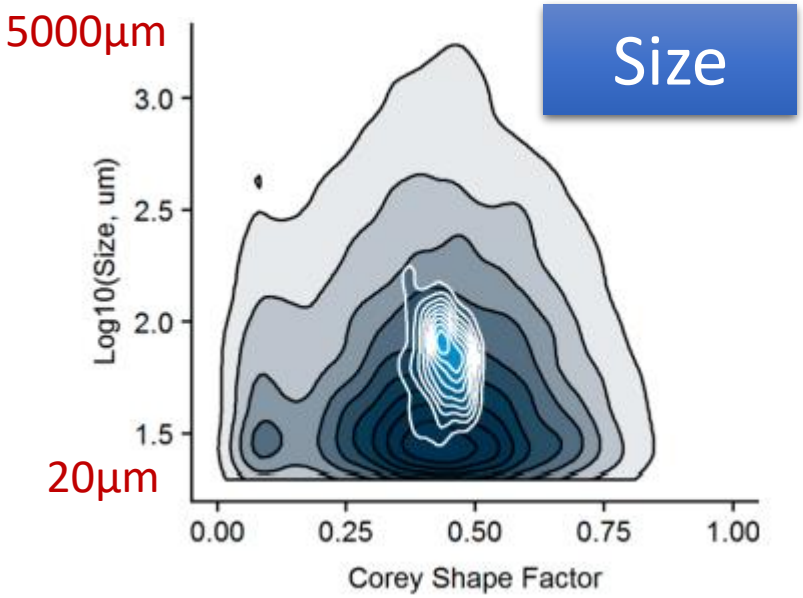
- Composition known and well characterization
- Original products approved for food contact

Key Observation 1: Current Microplastic Test Materials Are Not Representative

Typical Microplastic Test Material

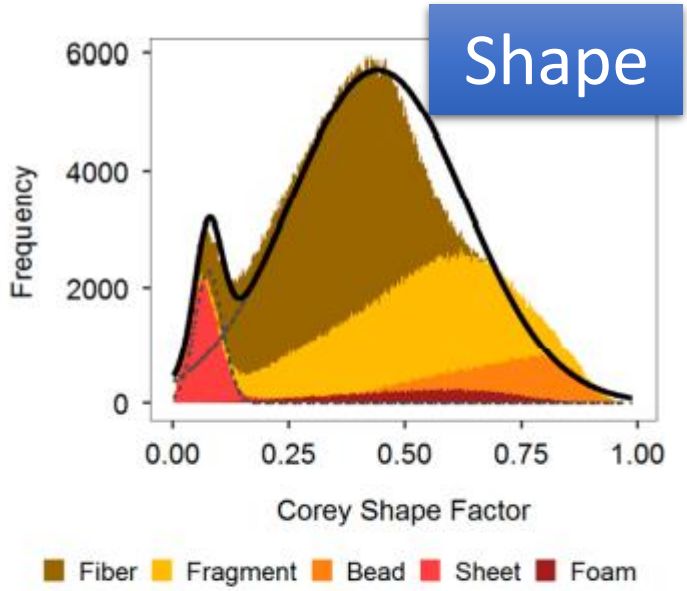
- Polystyrene
- Spherical, pristine
- Most < 5µm
- 10^{6-9}

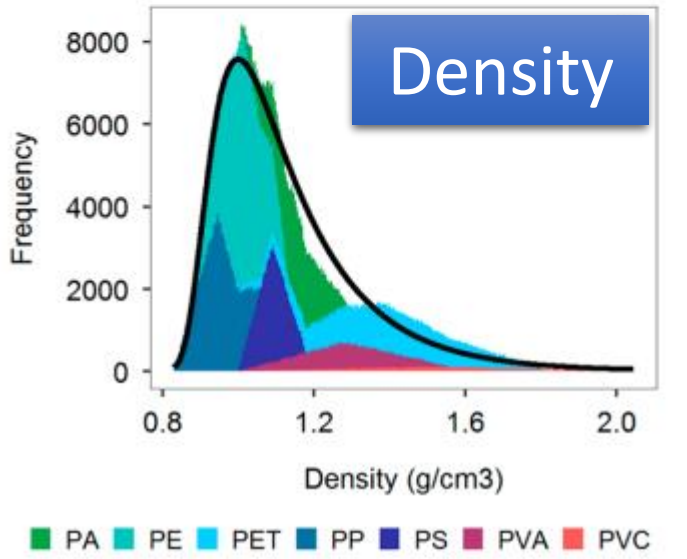
≠



Size

10^{2-3}, Aged





Kooi and Koelmans, 2019

Key Observation 2: Poor Quality Control

Typical Microplastic Test Material

Characterization Lacking

- Surface properties (charge, hydrophilicity, corona, chemical modifications, etc.)
- Surfactants/dispersants
- Solvents
- Preparation of the test material (e.g. Sonication)
- Property changes in the test system over time

Standardized Study Designs Lacking

- Robust study designs – GLP or GSP
- OECD test guidelines
- Increased applicability for risk assessment

Summary of Microplastics Human Health - Current & Future

	Microplastics Evaluations	Quality & Suitability
Current	Not representative	• Low overall quality • Limited suitability

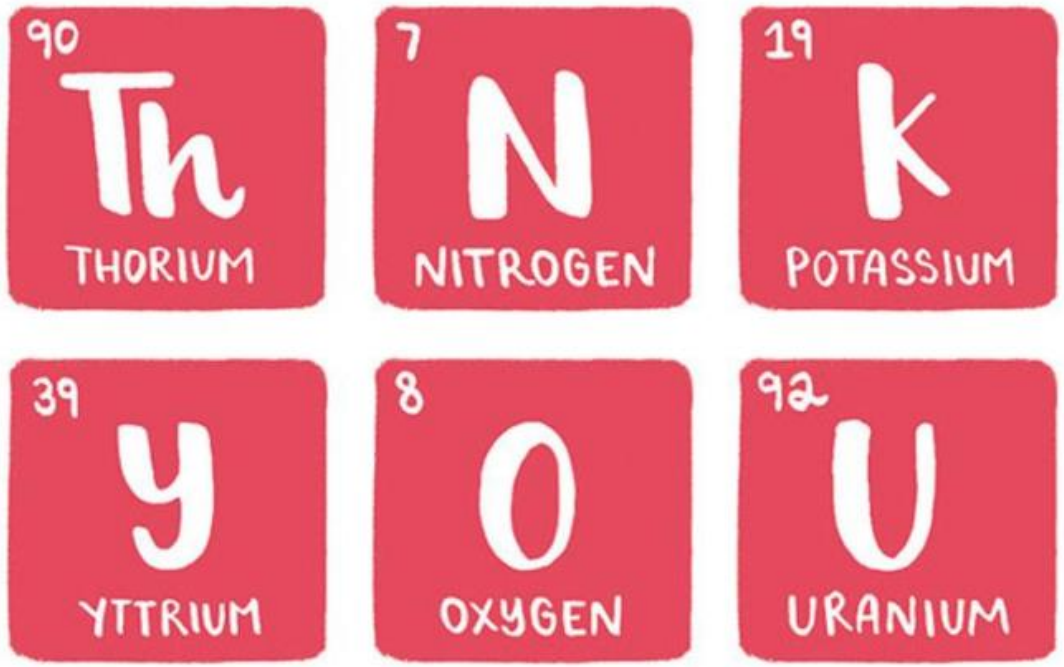
Within 5 years	• Selected by real world exposure data
	• Heterogenous
	  • Polymer types
	  • Size
	  • Shape
	  • Surface characteristics
		• High quality
		  • Particles well characterization
		  • Robust study designs
		  • Well suited for risk assessments
		• Toxicokinetics refined
		• General & specialized hazard studies (as needed)
		• Risk assessments

NEEDED –COLLABORATIONS BETWEEN DIVERSE SCIENTISTS

pft PARTICLE AND FIBRE TOXICOLOGY

SETAC®

SOT Society of Toxicology


90
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THORIUM
7
N
NITROGEN
19
K
POTASSIUM
39
Y
YTTRIUM
8
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OXYGEN
92
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URANIUM