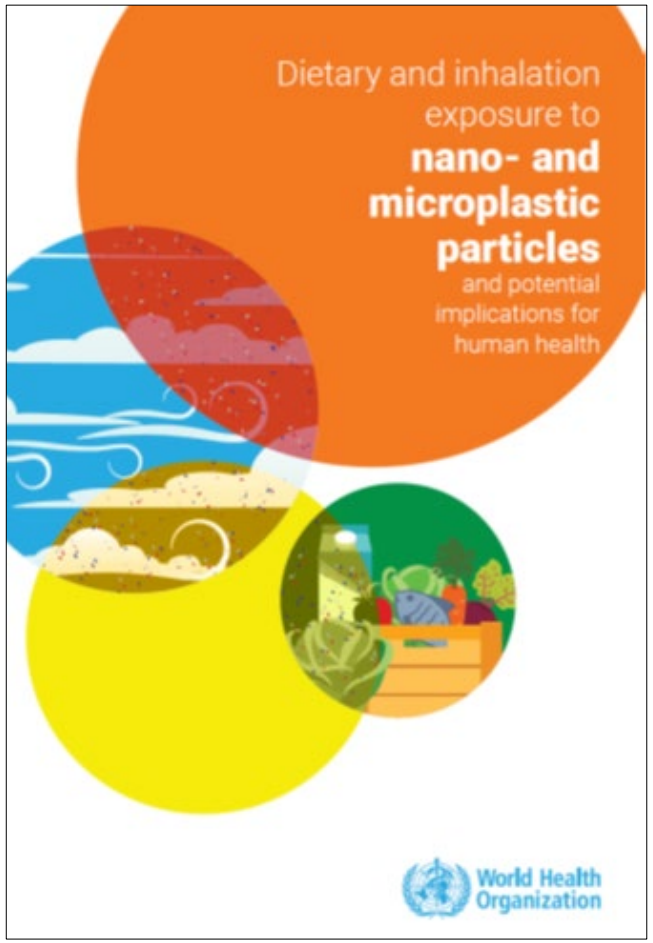
TG ENVIRONMENTAL RESEARCH

Dietary and inhalation exposure to nano- and microplastic particles and potential implications to human health

Todd Gouin

ACKNOWLEDGEMENTS



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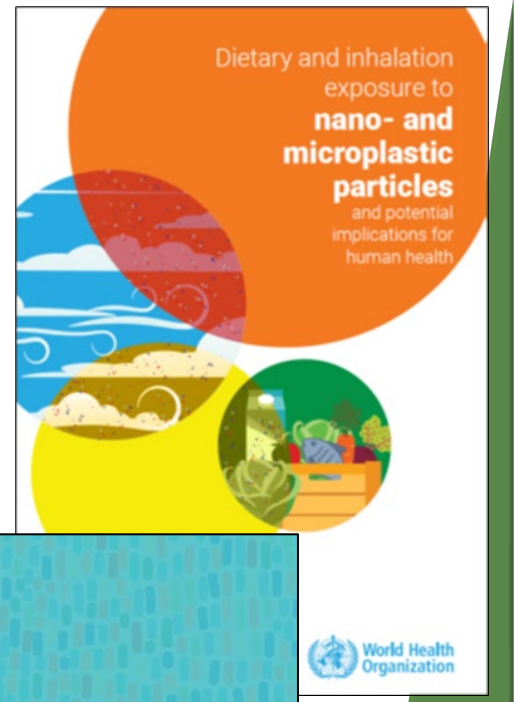
Nano- and Microplastic particles: WHO response

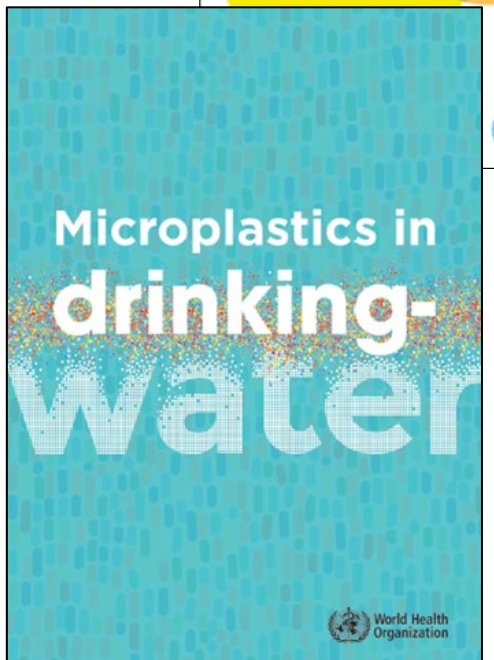
Context

- World Health Organization (WHO) regularly issues health-based guidelines on health and environment
- Emerging issues, such as plastics are identified as important issues in the health and environment department

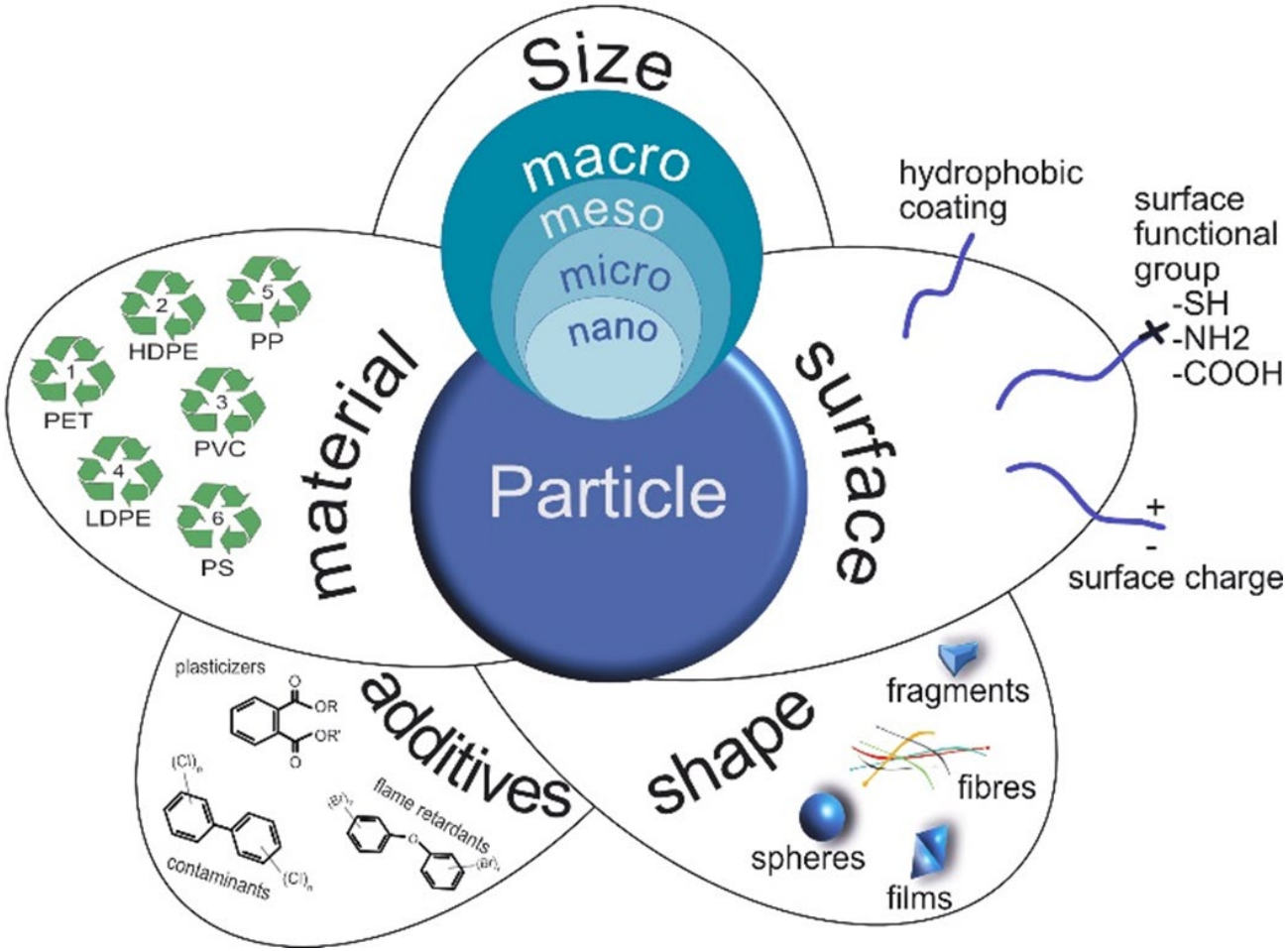
Technical work:

- Systematic review of data quality
  - Microplastics in Freshwaters and Drinking Water, Koelmans et al, 2019
  - Microplastics in air, Wright et al, 2021
  - Microplastic effect studies, Gouin et al, 2022
- WHO Report on microplastics and drinking-water (published 2019)
- Evaluation of human health implications that include additional relevant exposure routes (air, water, food and beverages) (published 2022)



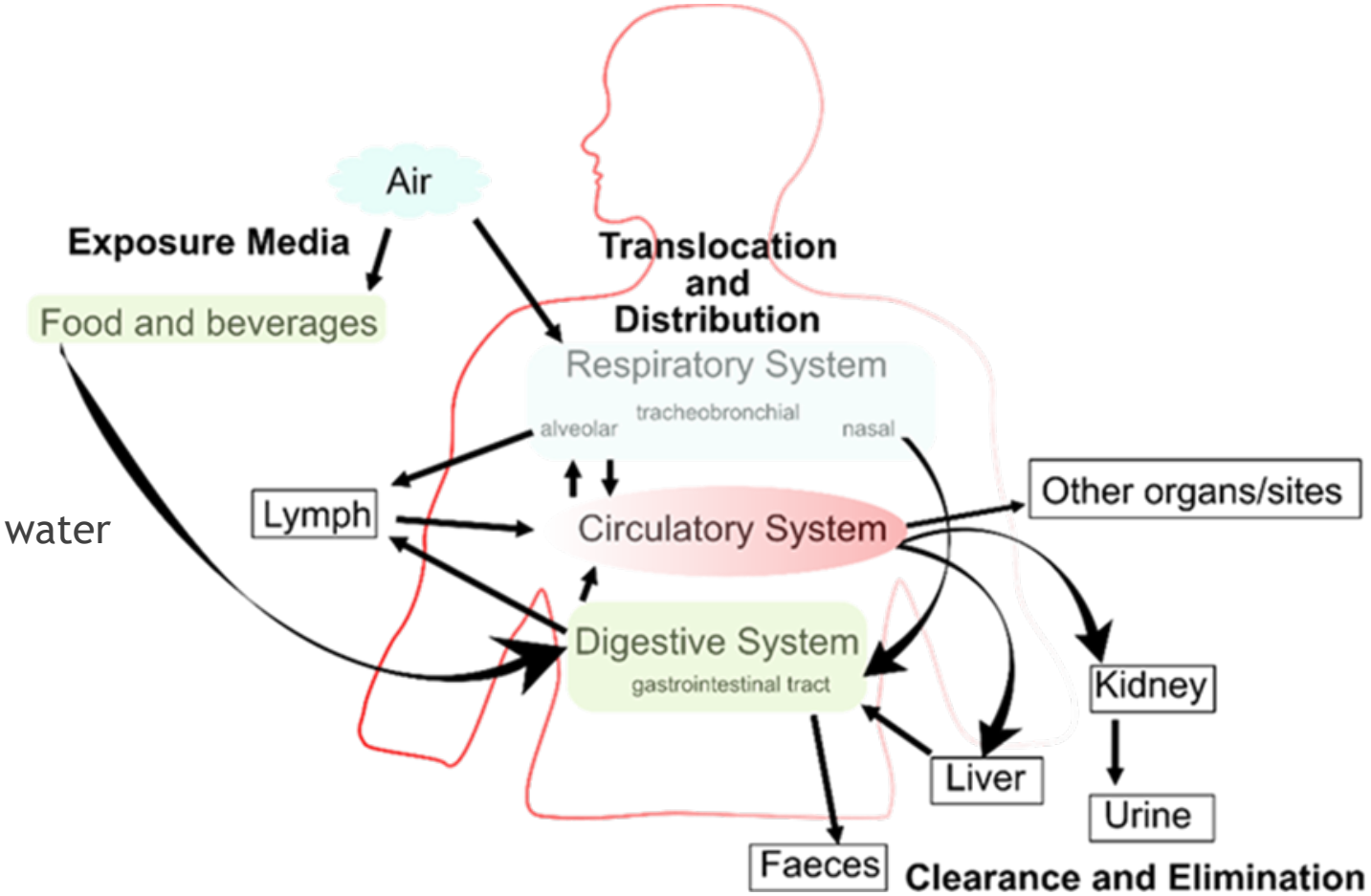


Complexity of nano- and microplastic particles



Nano- and Microplastic particles and human exposure

- What we know
  - Ubiquitous
    - Water
    - Air (indoor/outdoor)
    - Soil
  - Oral
    - **Particles >10µm**
    - Food, beverages and drinking water
- What we know we don't know
  - Inhalation and oral
    - **Particles <10µm**
  - Dermal
  - Elimination
    - Faeces



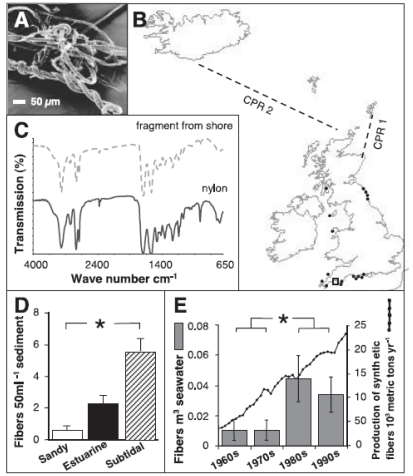
Dietary exposure

- Chasing the knowledge – reactionary response
- Evidence for widespread contamination of the marine environment
  - Seafood
  - Fish
  - Drinking water
- More recently exposure via:
  - Air
  - Soils
  - Food packaging

BREVIA 7 MAY 2004 VOL 304 SCIENCE www.sciencemag.org

Lost at Sea: Where Is All the Plastic?

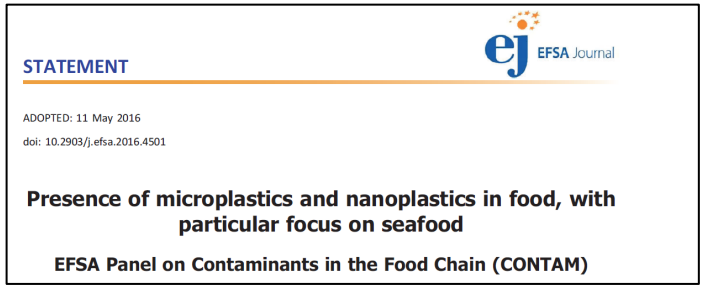
Richard C. Thompson,[1]* Ylva Olsen,[1] Richard P. Mitchell,[1] Anthony Davis,[1] Steven J. Rowland,[1] Anthony W. G. John,[2] Daniel McGonigle,[3] Andrea E. Russell[3]



"More work is needed to establish whether there are any environmental consequences of this debris."

Microplastic in seafood – per capita consumption

Author	Sample type	Portion size (g)	Region	Daily per capita consumption (g/d)	Particle concentration (MPs/g)[a]	Daily per capita ingestion (MPs/d)	Annual per capita ingestion (MPs/y)	Particle size (µm)
EFSA (2016)	Mussels	225	France		4	900[b]		25
Cho et al. (2019)	Oysters		Korea	0.84	0.07	0.06	21	43 - 300µm
Cho et al. (2019)	Mussels		Korea	0.67	0.12	0.08	29	43 - 300µm
Cho et al. (2019)	Manila clams		Korea	1.25	0.35	0.44	155	43 - 300µm
Cho et al. (2019)	Scallops		Korea	0.25	0.08	0.02	7	43 - 300µm
Renzi et al. (2018)	Mussels (cooked)	225	Italy			1395		>750
Li et al. (2018b)	Mussels	100	UK			100		5-250µm
Catarino et al. (2018)	Mussels		UK	0.23	1.5	0.3	123	0.2-2mm
Catarino et al. (2018)	Mussels		Spain, France, Belgium	8.75	1.5	12.7	4620	0.2-2mm
Devriese et al. (2015)	Prawns		Belgium	1.4	1.92	0.3	100	>200



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)

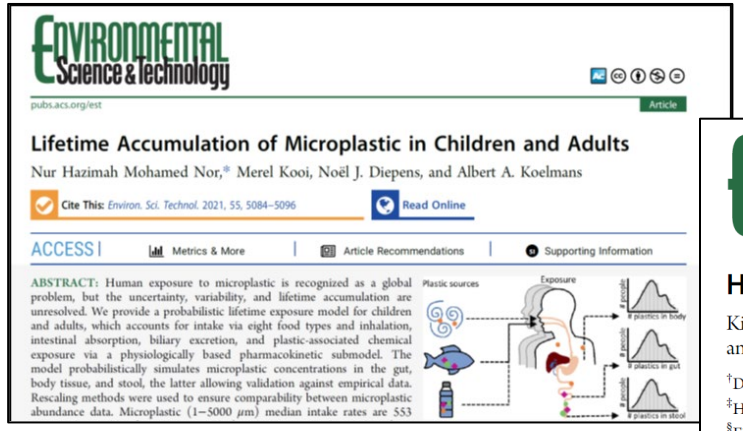
"For microplastics and nanoplastics, occurrence data in food, including effects of food processing, in particular, for the smaller sized particles (<150µm) should be generated. Research on the toxicokinetics and toxicity, including studies on local effects in the gastrointestinal (GI) tract, are needed as is research on the degradation of microplastics and potential formation of nanoplastics in the human GI tract."

Microplastic in seafood – sources of contamination

- Marine waters – filter feeders
  - Filter feeders ingest and accumulate MPs from contaminated seawater and sediment, resulting in dietary exposure for consumers of seafood products (van Cauwenberge and Janssen, 2014; Renzi et al., 2018)
- Food processing and/or packaging
  - Observations that higher levels of contamination associated with processed seafood.
    - Processed mussels with higher levels of MPs as compared to live mussels from farmed sources, implying potential contamination during the de-shelling and cleaning processing of the mussels (Li et al., 2018).
    - Canned fish possibly contaminated during processing and packaging steps (Karami et al., 2018).
- Atmospheric deposition
  - Observations that contamination via deposition to possibly be >100x than contamination via the environment (Catarino et al., 2018)

Dietary exposure of microplastic particles

- Concerns regarding the representatives of food and beverage categories that have been studied to date.
  - Chasing the knowledge
    - Significant underrepresentation of human daily caloric intake
    - What are the levels in more representative foods and beverages?
    - Are there cultural, socioeconomic, age and gender differences?



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Article

Lifetime Accumulation of Microplastic in Children and Adults

Nur Hazimah Mohamed Nor,* Merel Kooi, Noël J. Diepens, and Albert A. Koelmans

Cite This: *Environ. Sci. Technol.* 2021, 55, 5084−5096 | Read Online

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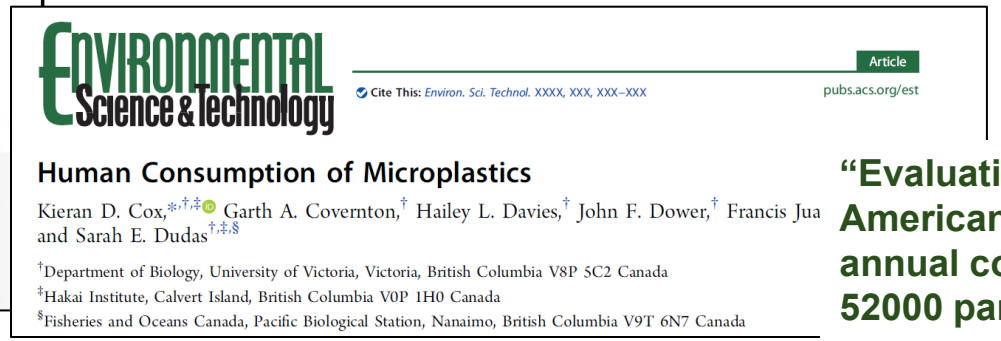
ABSTRACT: Human exposure to microplastic is recognized as a global problem, but the uncertainty, variability, and lifetime accumulation are unresolved. We provide a probabilistic lifetime exposure model for children and adults, which accounts for intake via eight food types and inhalation, intestinal absorption, biliary excretion, and plastic-associated chemical exposure via a physiologically based pharmacokinetic submodel. The model probabilistically simulates microplastic concentrations in the gut, body tissue, and stool, the latter allowing validation against empirical data. Rescaling methods were used to ensure comparability between microplastic abundance data. Microplastic (1−5000 μm) median intake rates are 553



Environmental Science & Technology

Article

Cite This: *Environ. Sci. Technol.* XXXX, XXX, XXX−XXX

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Human Consumption of Microplastics

Kieran D. Cox,*[†,‡] Garth A. Covernton,[†] Hailey L. Davies,[†] John F. Dower,[†] Francis Jua and Sarah E. Dudas[†,‡,§]

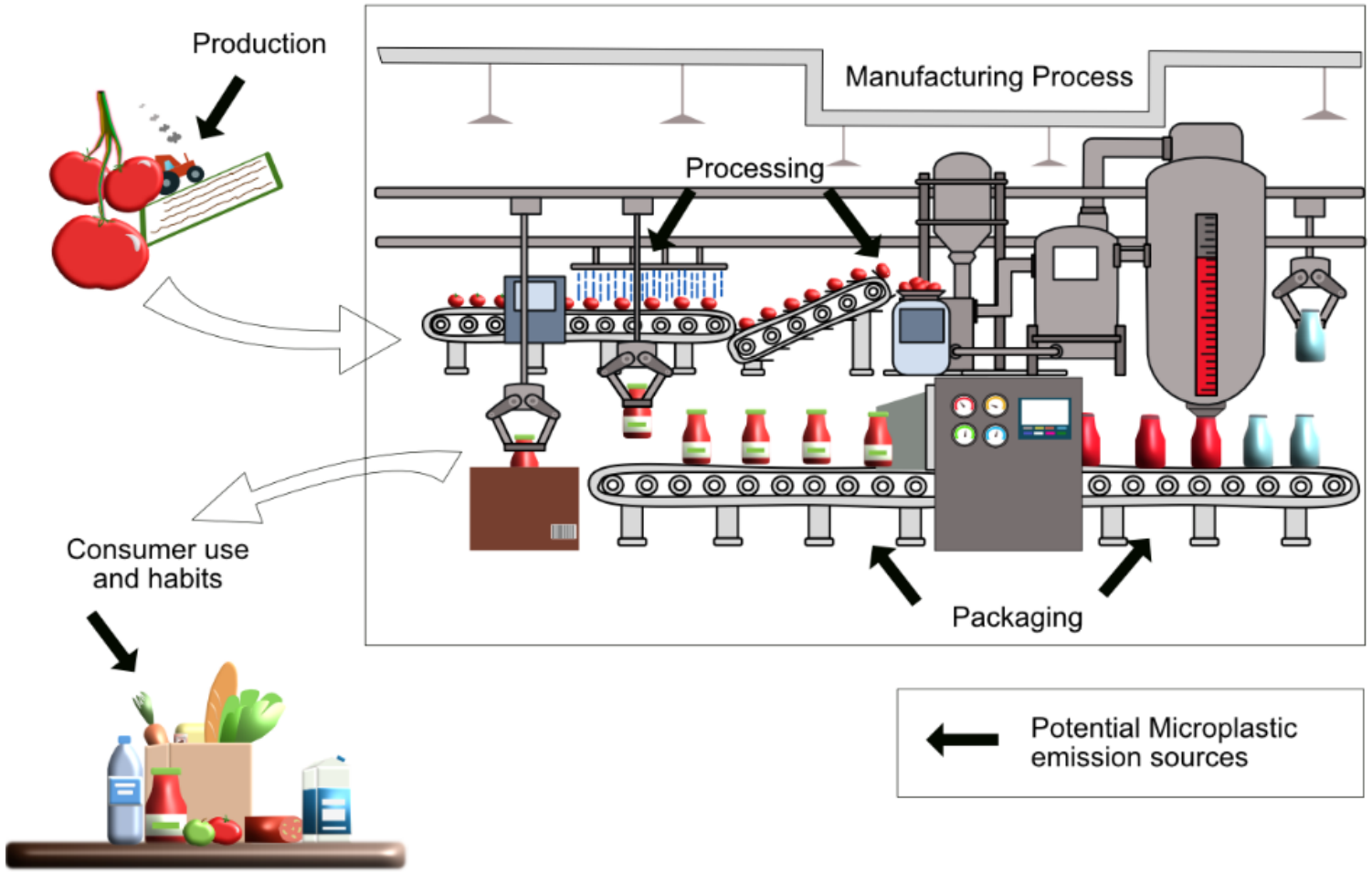
[†]Department of Biology, University of Victoria, Victoria, British Columbia V8P 5C2 Canada

[‡]Hakai Institute, Calvert Island, British Columbia V0P 1H0 Canada

[§]Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, British Columbia V9T 6N7 Canada

"Evaluating approximately 15% of Americans' caloric intake, we estimate that annual consumption ranges from 39000 to 52000 particles depending on age and sex."

Developing a targeted exposure assessment



Holistic approach that considers total food basket and which evaluates potential sources throughout the whole life cycle.

What about nano-sized plastic particles?

- Characterization and quantification of environmental exposure needs to address a number of key challenges:
  - Lack of analytical methods
    - How to isolate from complex matrices
      - Sample collection
      - Digestion, filtration, sample clean-up and preparation
    - Availability of quantitative analytical tools and QA/QC

Research needs

- Standard methods:
  - Sampling and analysis of NMP in air, water, food and beverages require robust, quality-assured methods and suitable **Reference Standards representative of environmentally relevant NMP**.
- Particle characterization:
  - Quality-assured environmental monitoring studies should be conducted to characterize the distributions of size, shape and composition of NMP in the environment for studies of the effects of exposure on human health and to prepare reference standards for environmentally relevant testing of toxicity.
- Sources:
  - The contributions of different factors would guide strategies for mitigating exposure.
- Uptake and fate for both inhalation and oral ingestion exposure:
  - More information is required on the absorption, distribution and elimination of NMP.
- Toxicology
  - Quality-assured experiments suitable for risk assessment should be conducted, with adequate characterization of exposure to the types of NMP to which humans are most commonly exposed.

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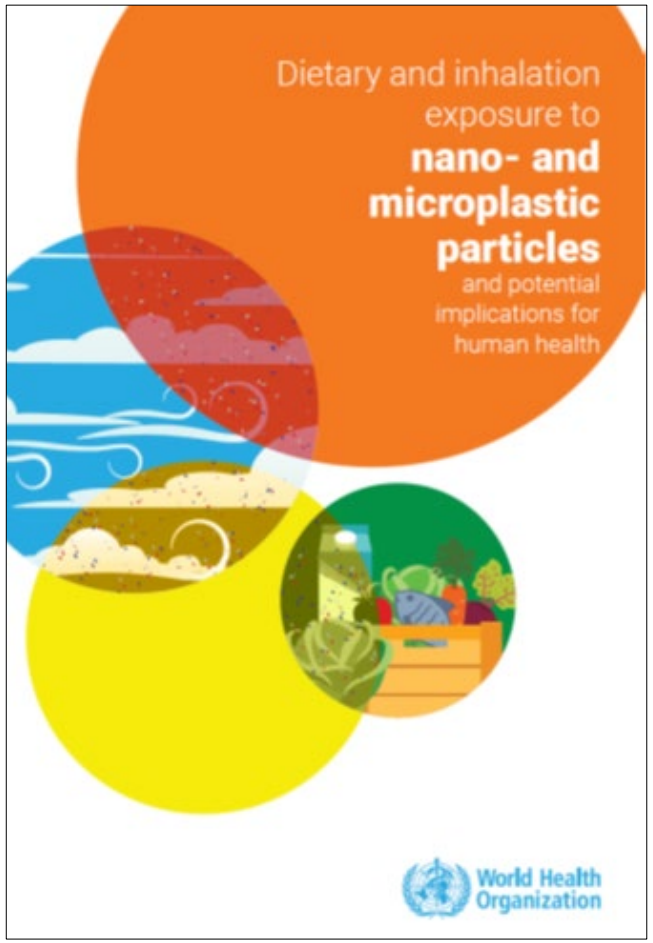

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Questions?