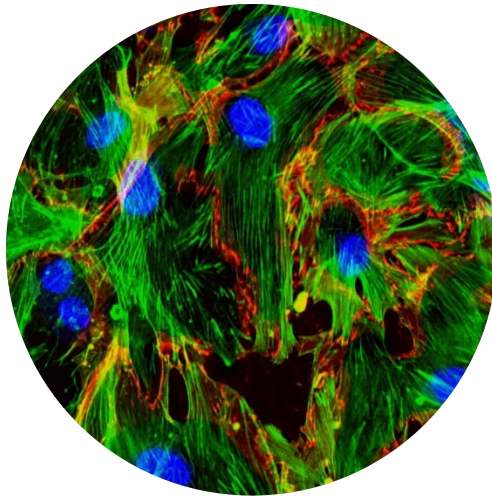


Microplastics Health Effects Symposium: A Webinar Series

Influence of Particle chemistry on Uptake, Transport and Toxicity

Hans Bouwmeester, Monday November 2nd, 2020



*Hosted By: Southern California Coastal Water Research Project Authority (SCCWRP); San Francisco Estuary Institute,
University of Toronto, In coordination with the California Water Resources Control Board
and the California Ocean Protection Council*

Accumulation and fragmentation of plastic debris in global environments

David K. A. Barnes^{1,*}, Francois Galgani², Richard C. Thompson³
and Morton Barlaz⁴

Science of the Total Environment 702 (2020) 134455



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

Review

Environmental exposure to microplastics: An overview on possible human health effects

Ioana Correia Prata^{a,*}, João P. da Costa^a, Isabel Lopes^b, Armando C. Duarte^a, Teresa Rocha-Santos^a

Plastic debris in the open ocean

Andrés Cózar^{a,1}, Fidel Echevarría^a, J. Ignacio González-Gordillo^a, Xabier Irigoien^{b,c}, Bárbara Úbeda^a,
Santiago Hernández-León^d, Álvaro T. Palma^e, Sandra Navarro^f, Juan García-de-Lomas^a, Andrea Ruiz^g,
María L. Fernández-de-Puelles^h, and Carlos M. Duarte^{i,j,k,l}



WAGENINGEN
UNIVERSITY & RESEARCH

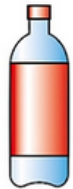
IA

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. Russell³



LARGER PLASTIC PRODUCTS



UV

WAVE ACTION

CLOTHING



FIBRES



NURDLES



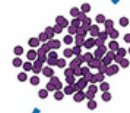
Small plastic pellets
used in industry

PERSONAL HYGIENE PRODUCTS



Toothpaste, shower gel,
facewash

MICROBEADS

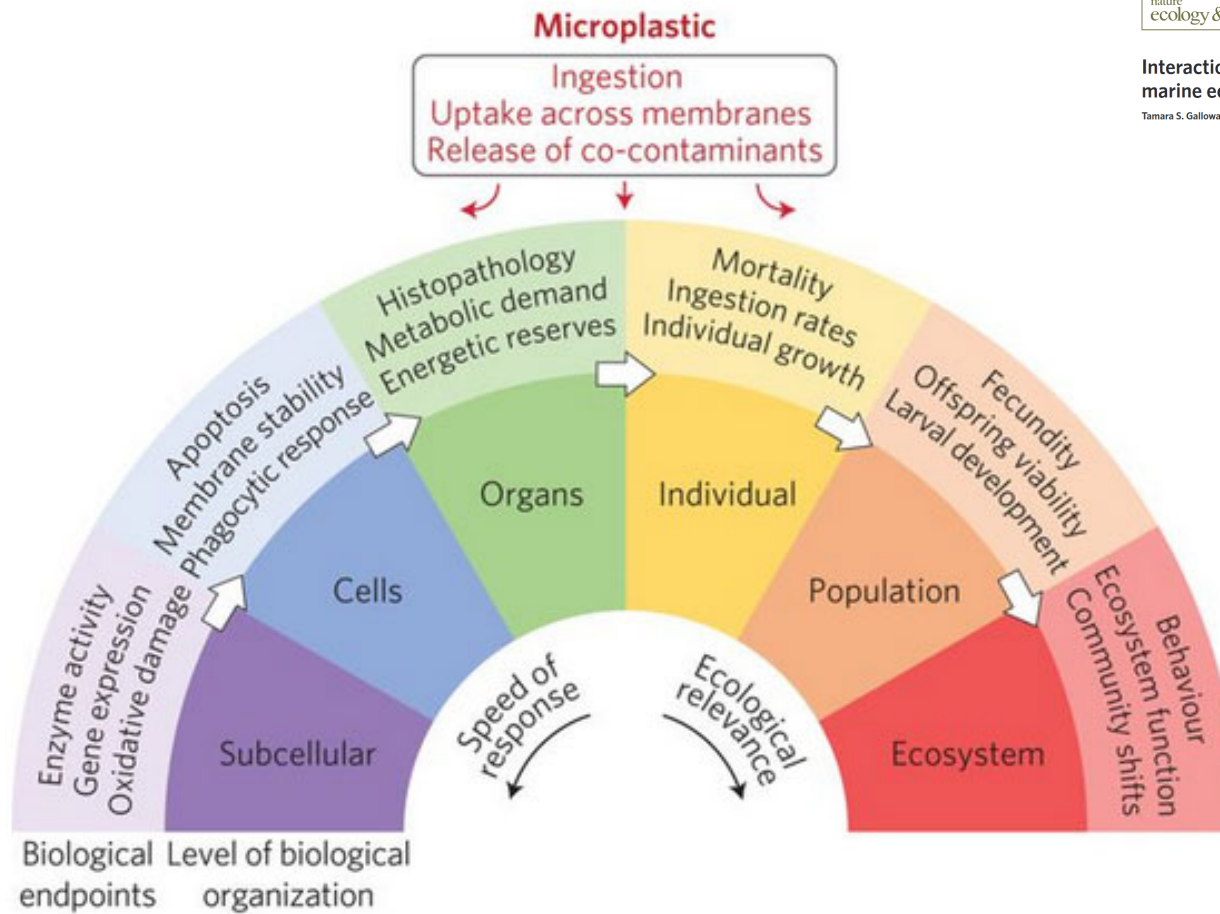


MICROPLASTIC

5mm

Interactions of microplastic debris throughout the marine ecosystem

Tamara S. Galloway*, Matthew Cole and Ceri Lewis

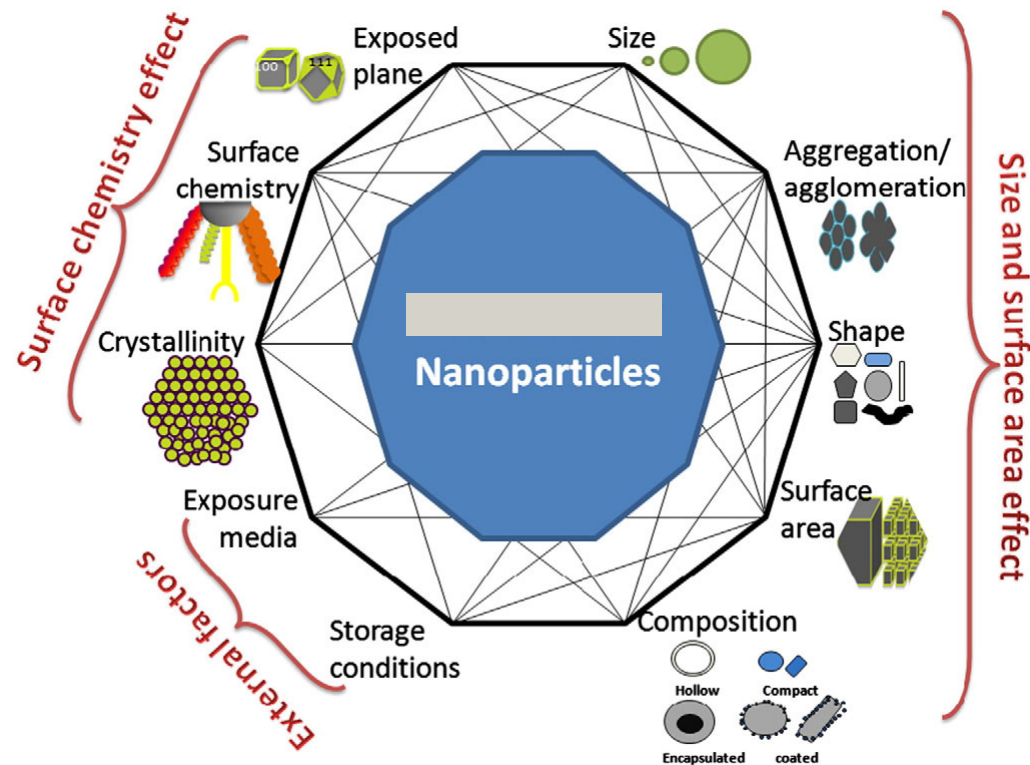


Topics to cover

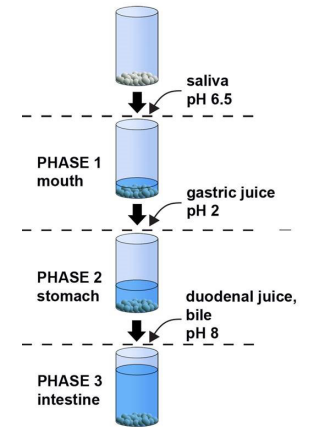
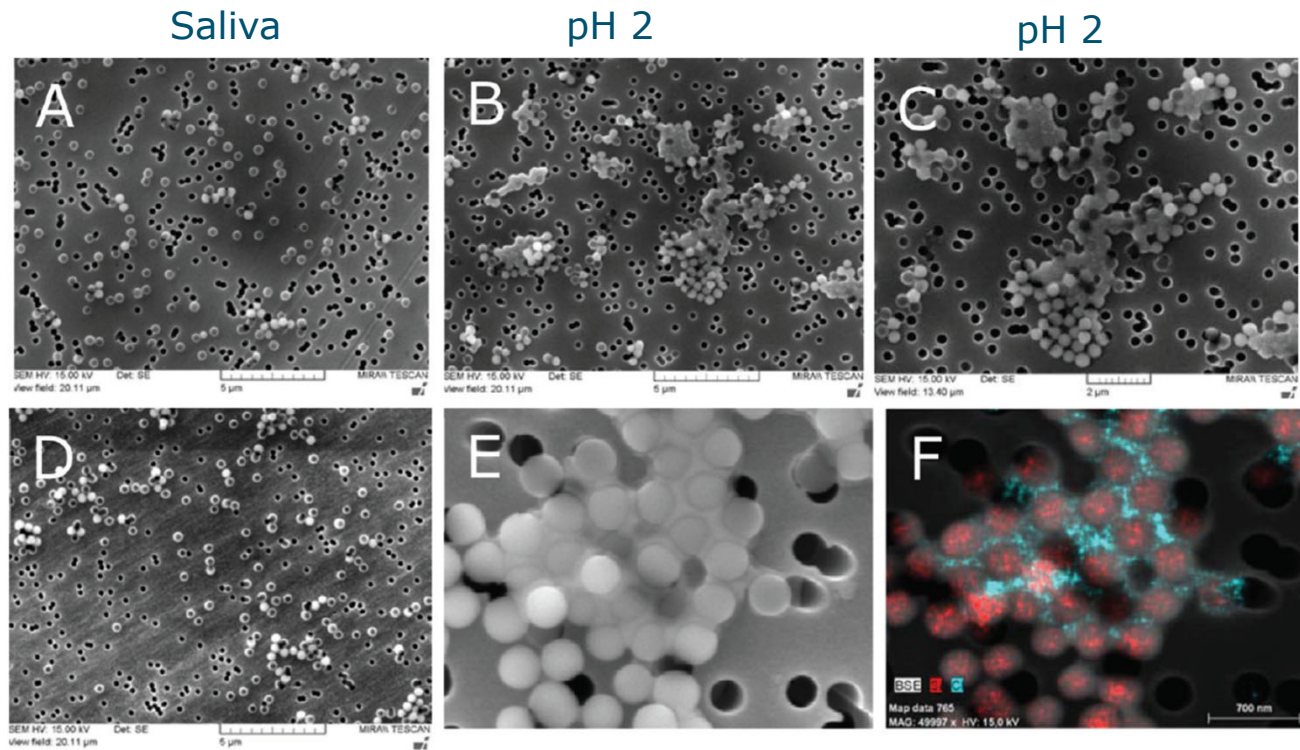
- Lessons-learned form engineered nanoparticles
- Biomolecular corona?
- Novel approaches in human risk assessment
- Critical points

Interactions of particles with their environment

- Intrinsic properties
 - Size, shape, ...
 - Polymer type
- Extrinsic properties
 - Charge
 - Biomolecules
 - ...



Effect of stomach and intestinal conditions of particles

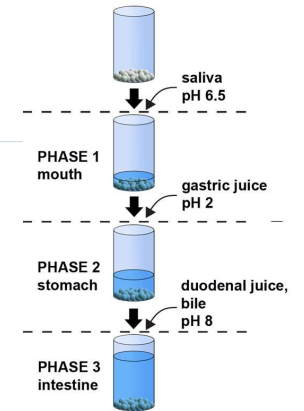
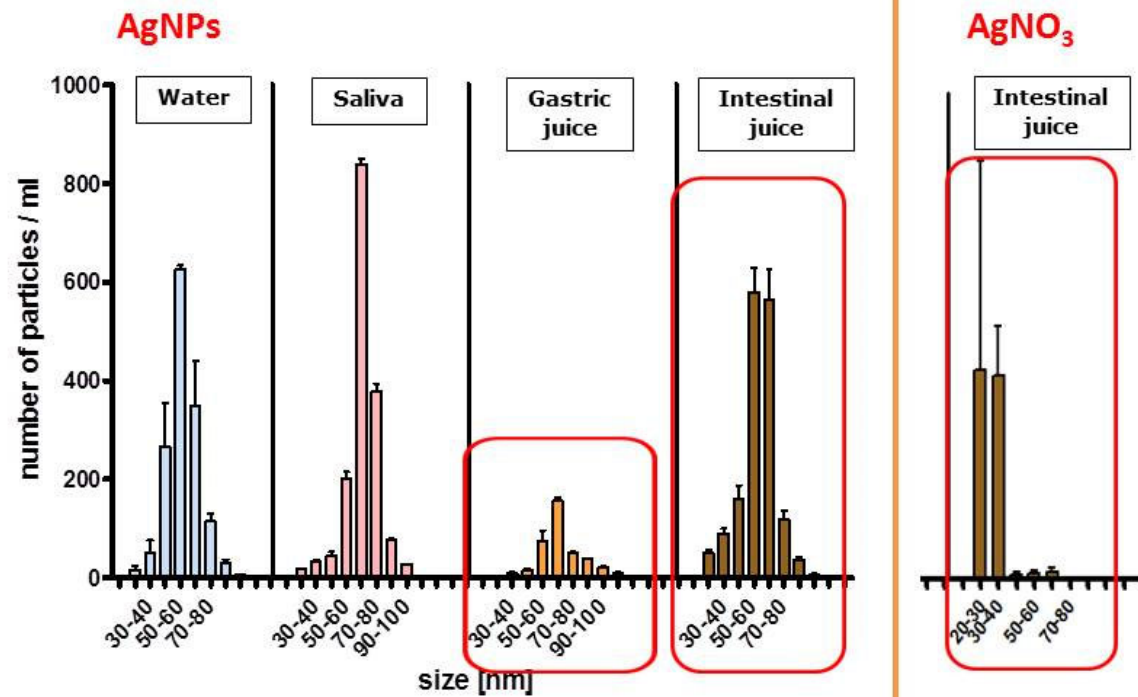


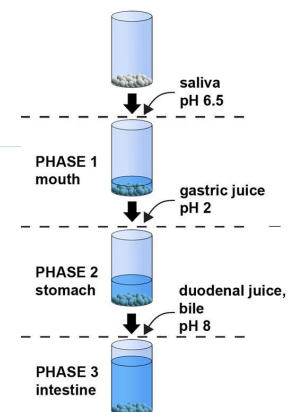
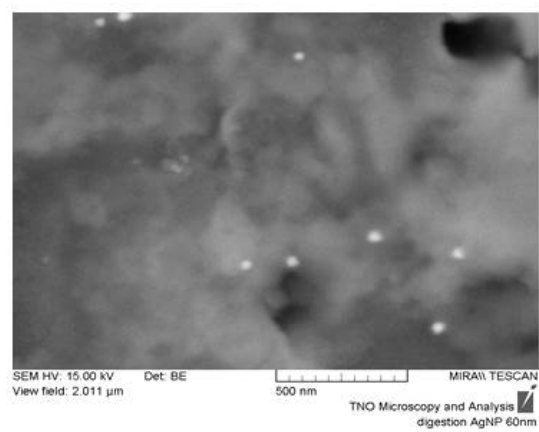
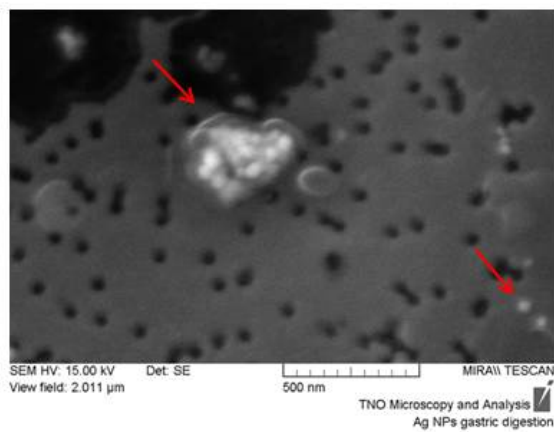
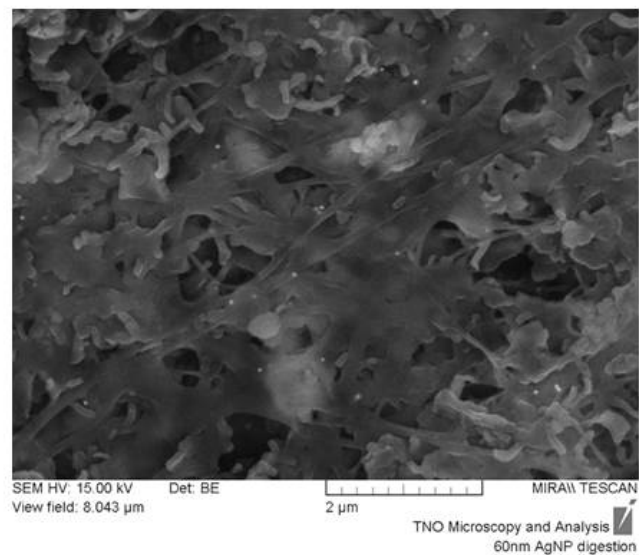
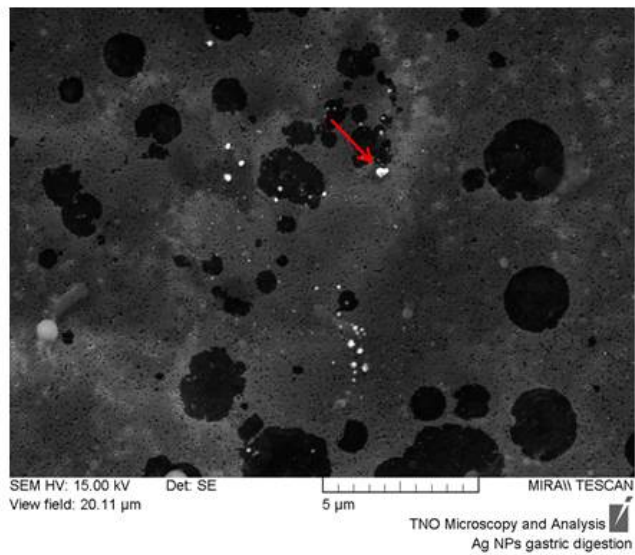
■ 500 nm SiO₂ NP

From pH 2 to pH 7

Enlarged in pH 2

Digestion with proteins

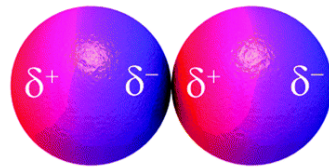




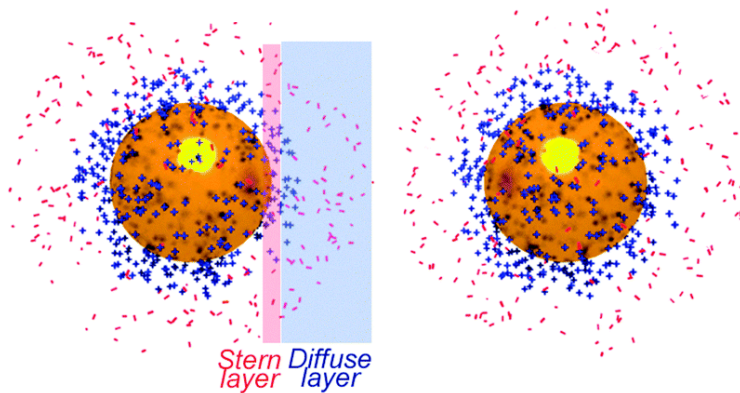
50 nm Ag NP

Agglomerates of particles

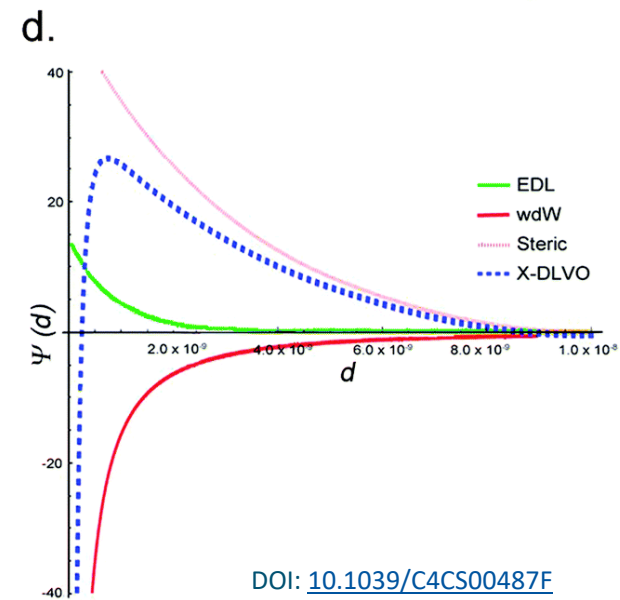
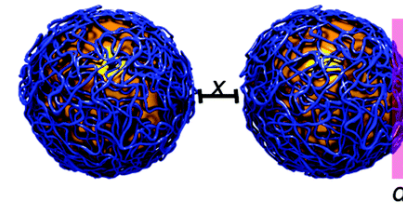
a. Van der Waals attractive (vdW)



b. Electric double layer (EDL)



c. Steric repulsion

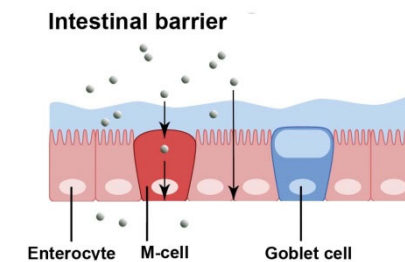
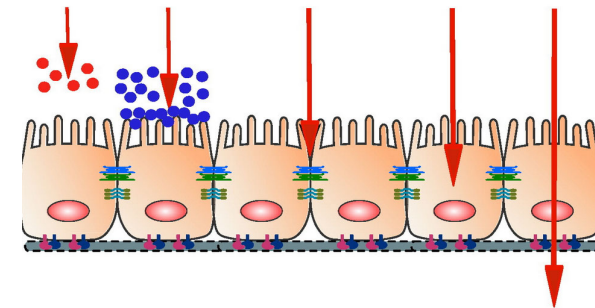


Topics to cover

- Lessons-learned form engineered nanoparticles
- Biomolecular corona?
- Novel approaches in human risk assessment
- Critical points

Intestinal uptake

- Transcellular through normal intestinal enterocytes
- Paracellular transport (between enterocytes)
- Peyer's patches intestinal lymphatic tissue containing M cells = specialized phagocytotic enterocytes

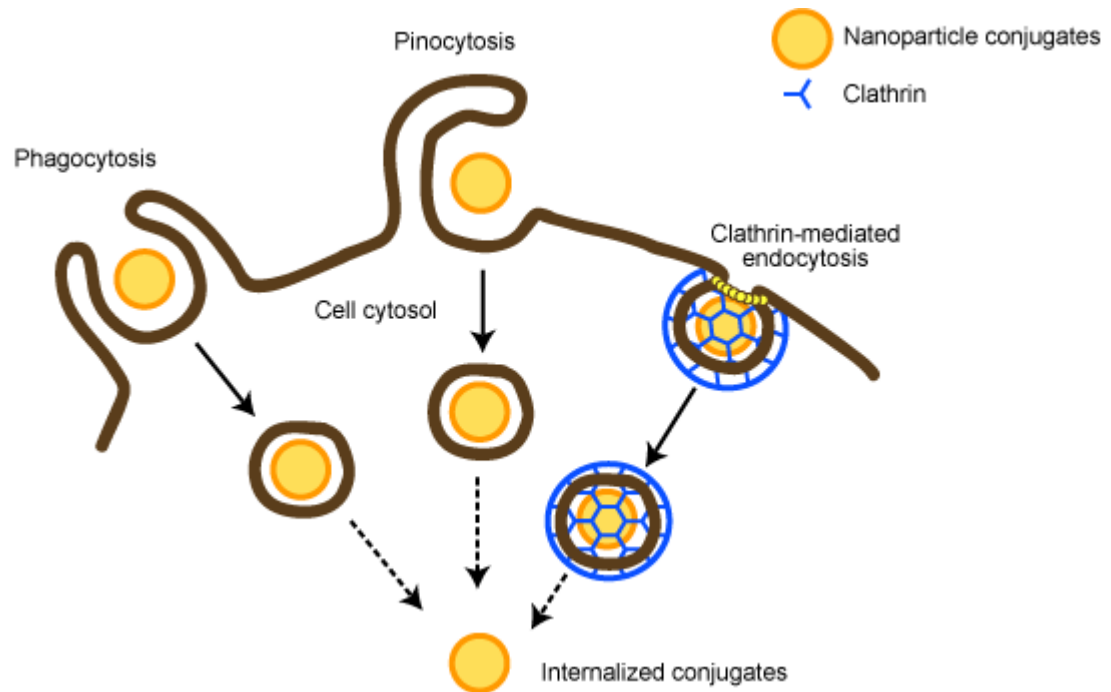


Mechanism of uptake

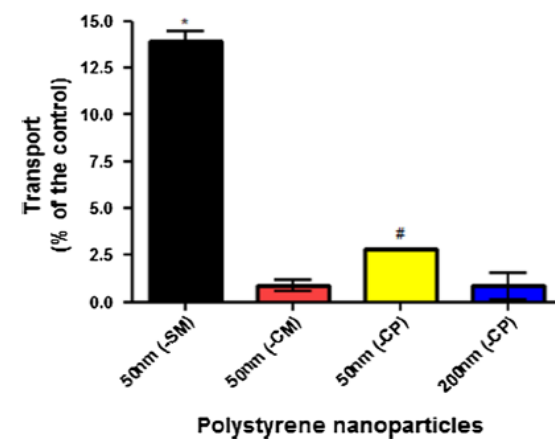
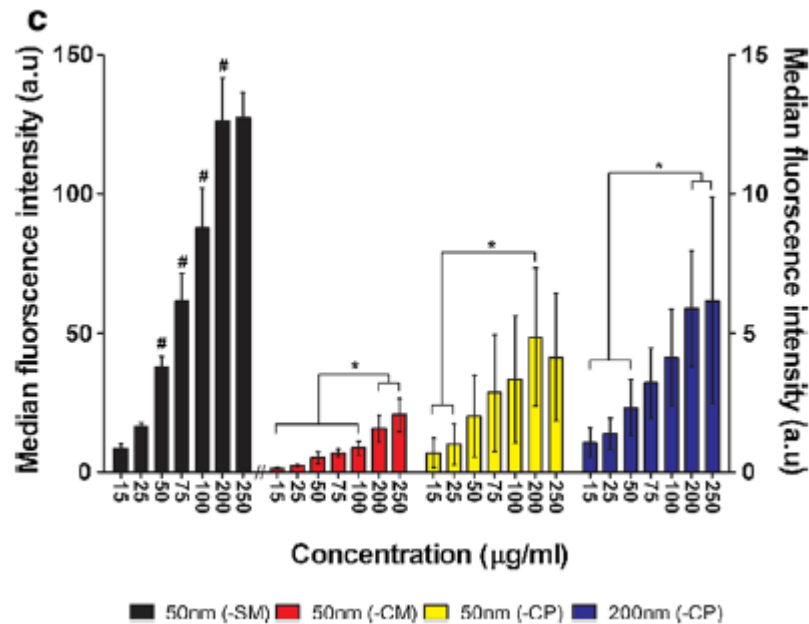
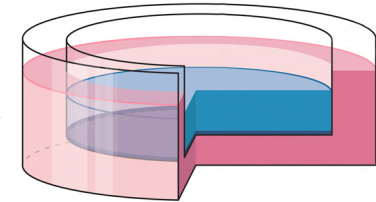
Effects of:

- Intrinsic properties
- Extrinsic properties

On transport rates ...?



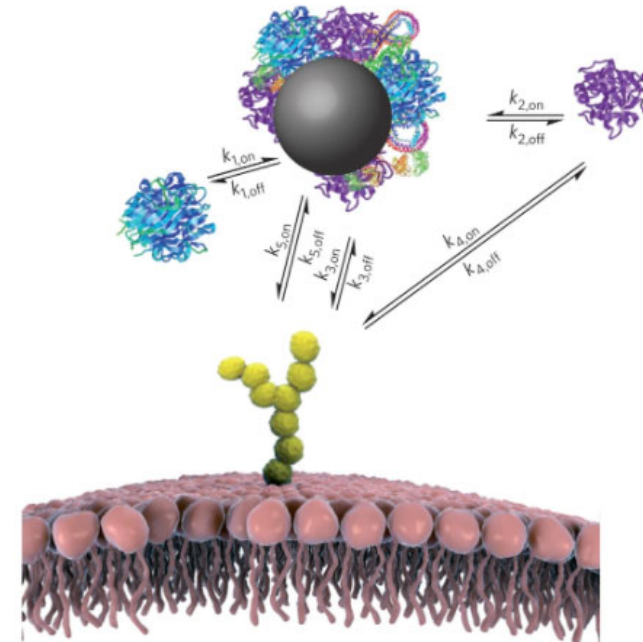
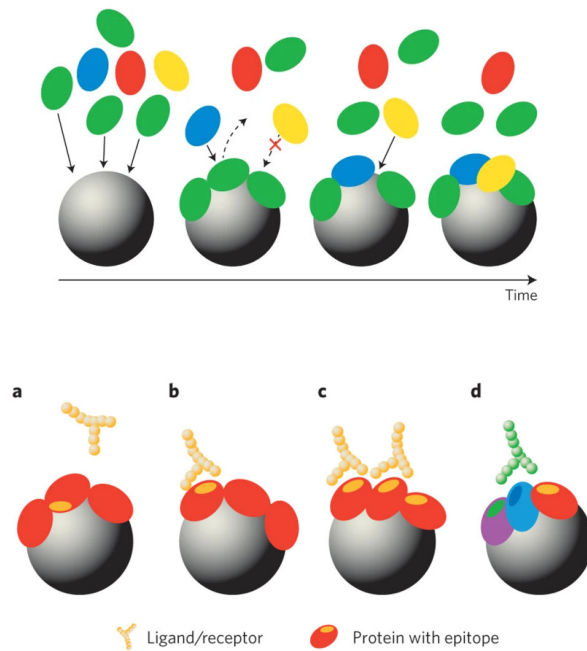
Role of surface coating of particles



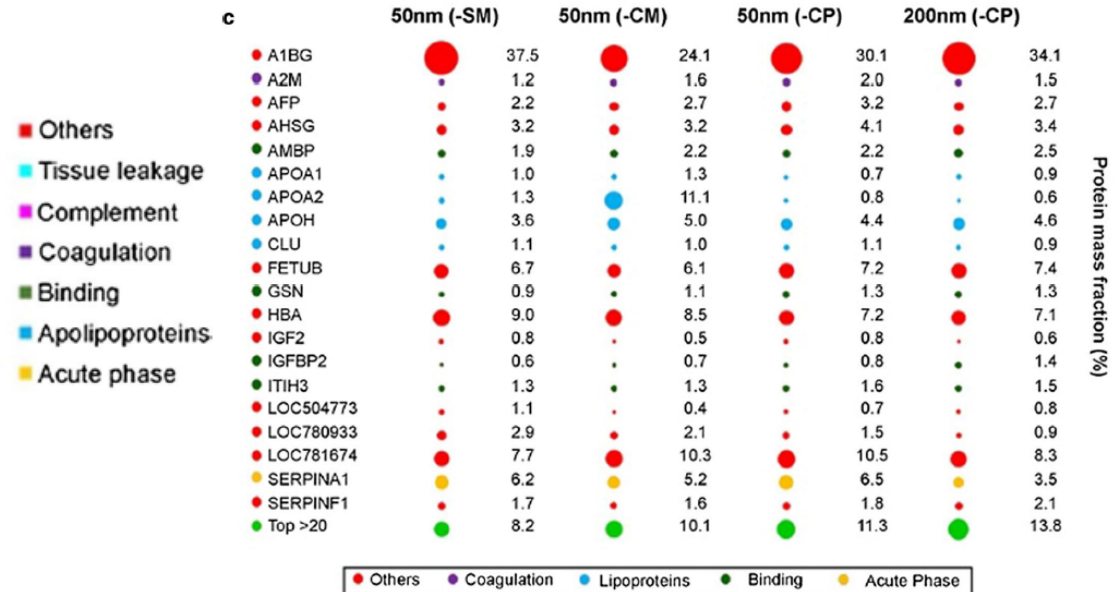
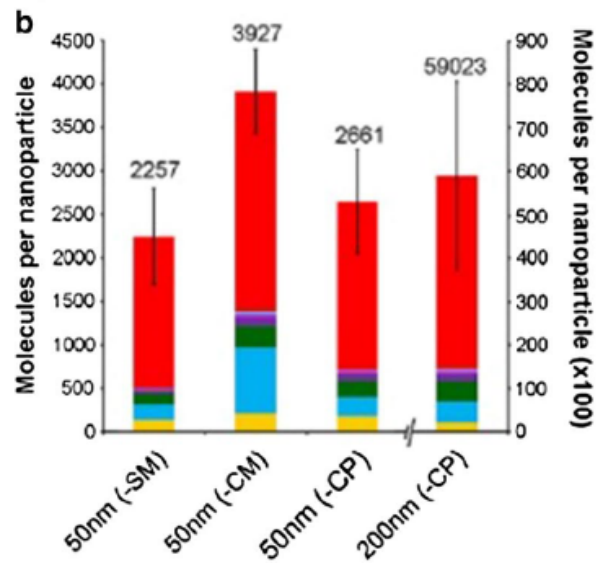
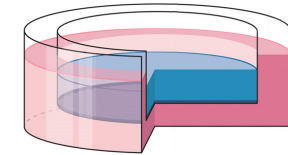
Biomolecular layer on particles

Biomolecular coronas provide the biological identity of nanosized materials

Marco P. Monopoli^{1,2}, Christoffer Åberg¹, Anna Salvati^{1,2} and Kenneth A. Dawson^{1*}



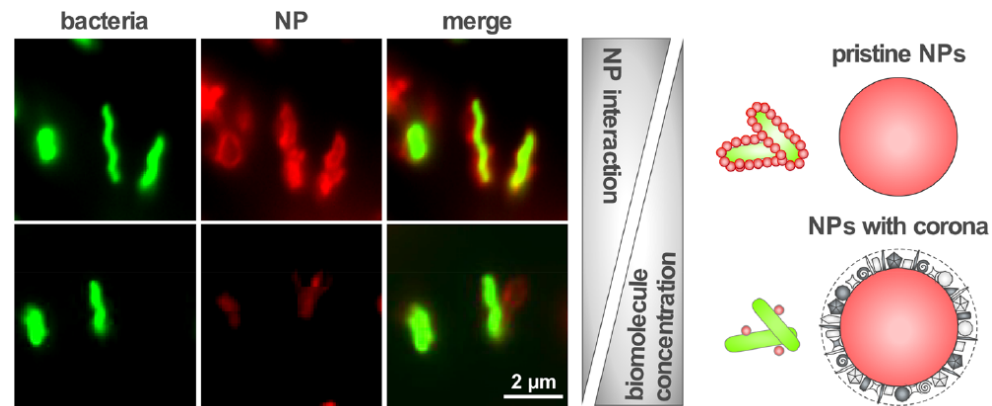
Surface coating dependent protein coverage



Protein corona affects interactions with bacteria

Biomolecules in corona

- Microbial fragments
- Environmental
 - Chemicals
 - Lipids
 - Proteins
 - ...

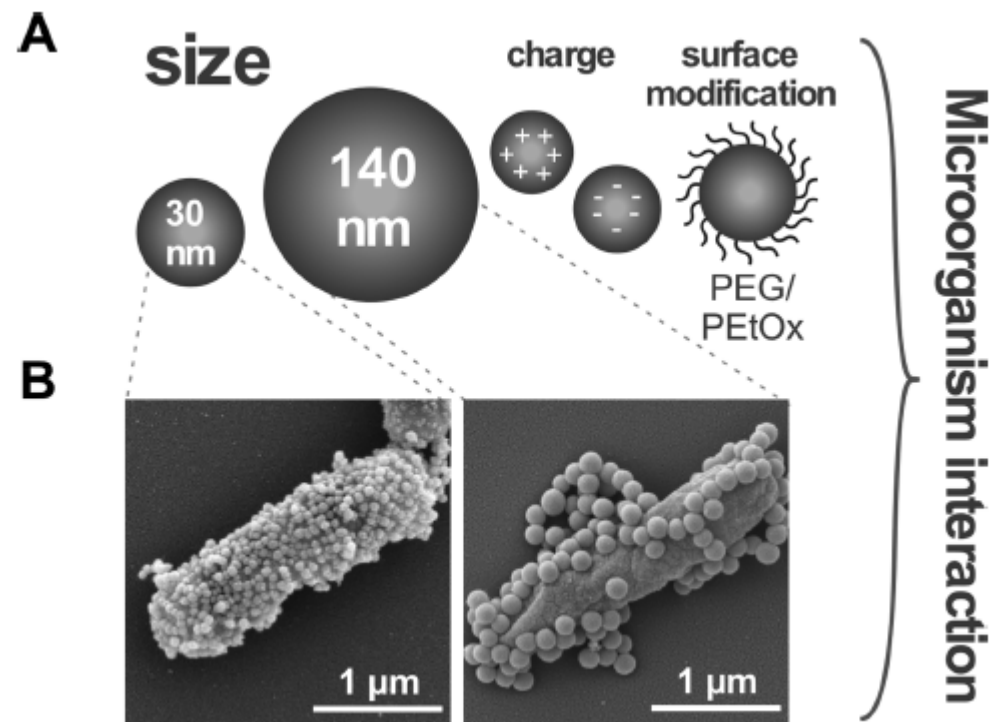


ACS NANO
Cite This: ACS Nano 2018, 12, 6351–6359
www.acsnano.org

Small Meets Smaller: Effects of Nanomaterials on Microbial Biology, Pathology, and Ecology

Roland H. Stauber,^{*,†} Svenja Siemer,[‡] Sven Becker,[‡] Guo-Bin Ding,^{†,‡} Sebastian Strieth,[‡] and Shirley K. Knauer^{*,§}

Interactions of particles and micro-organisms



Particles in human tissues

- 15 post mortem human liver spleen
- Sample preparation techniques
- Validation of Single particle ICP-HRMS
 - LODs (size) = 85 nm;
 - LODn (number) = $0.8 \times 109/\text{kg}$;
 - LODc (calculated Ti in particles) = 0.005 mg/kg
- Validation ICP-HRMS
 - LODt (total-Ti) = 0.01 mg/kg

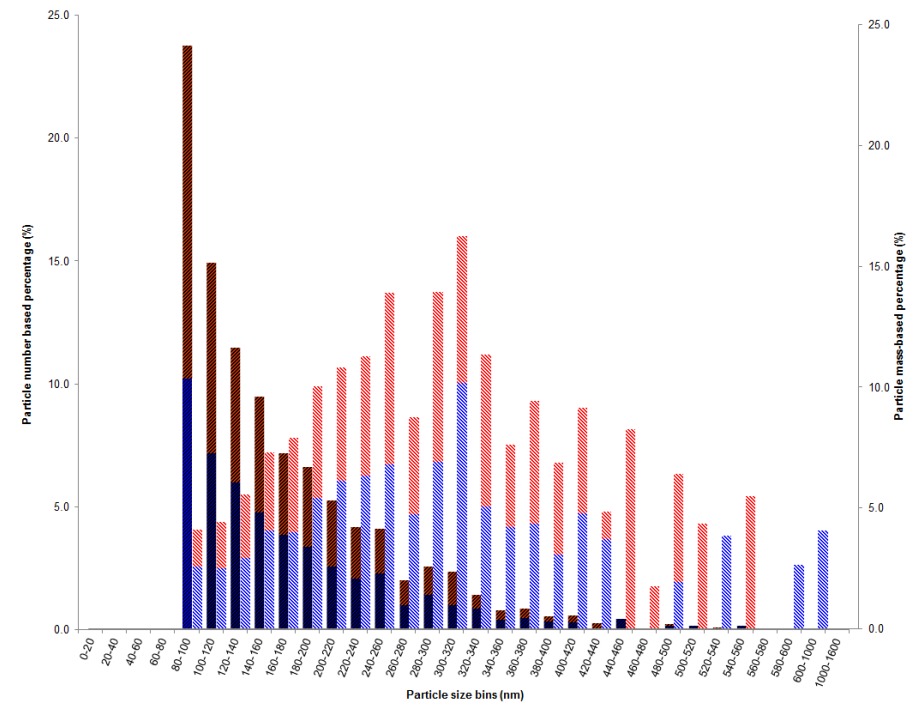
RESEARCH

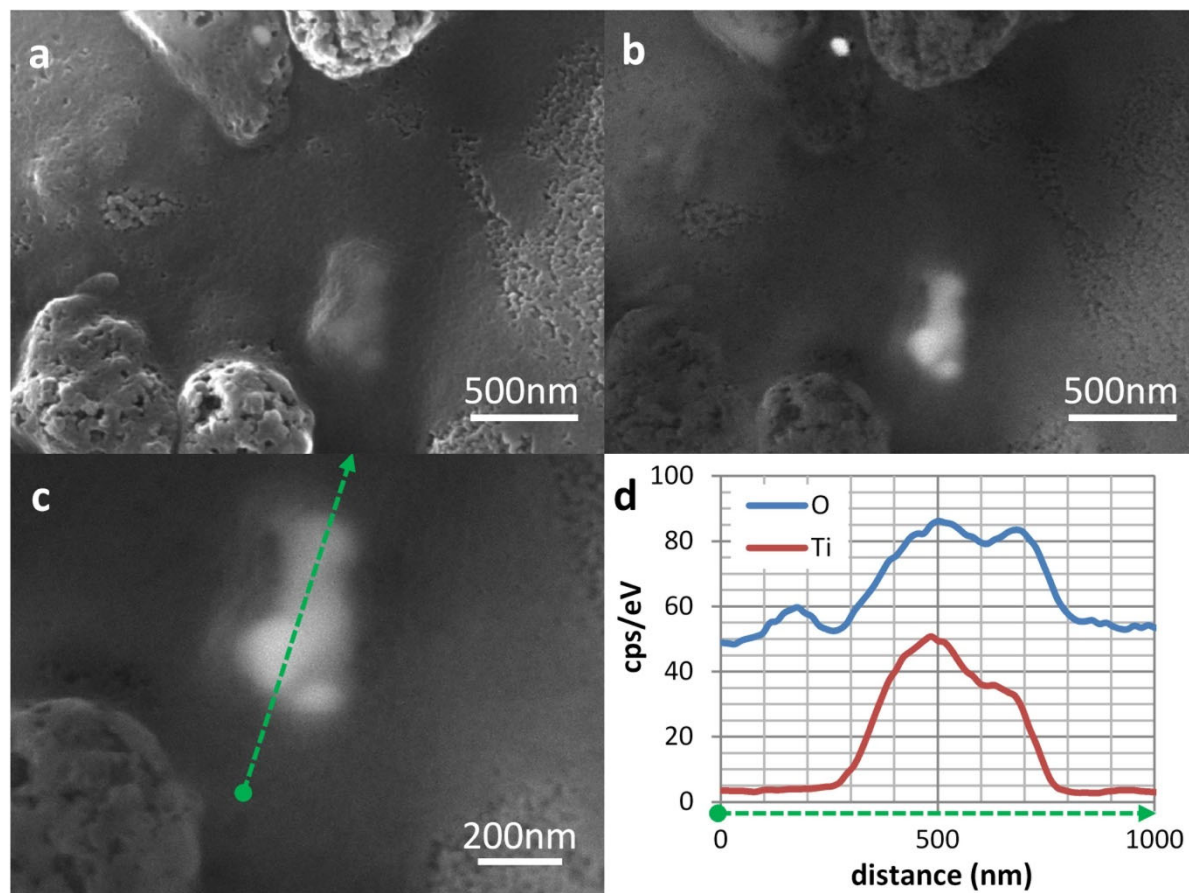
Open Access



Detection of titanium particles in human liver and spleen and possible health implications

M. B. Heringa^{1*}, R. J. B. Peters², R. L. A. W. Bleyers³, M. K. van der Lee², P. C. Tromp⁴, P. C. E. van Kesteren¹, J. C. H. van Eijkeren¹, A. K. Undas², A. G. Oomen¹ and H. Bouwmeester²⁵



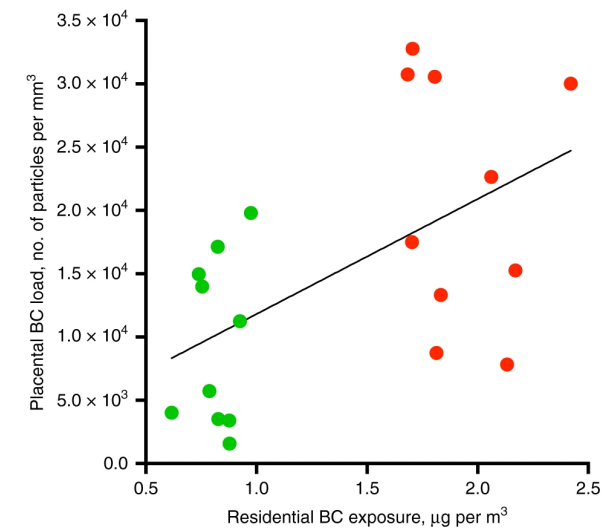
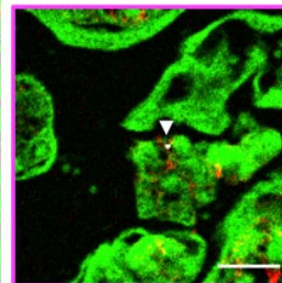
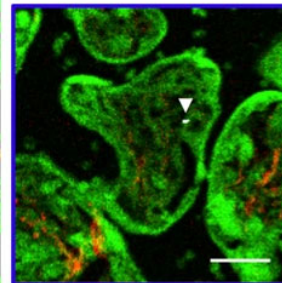
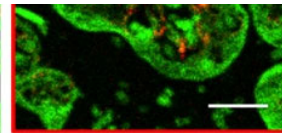
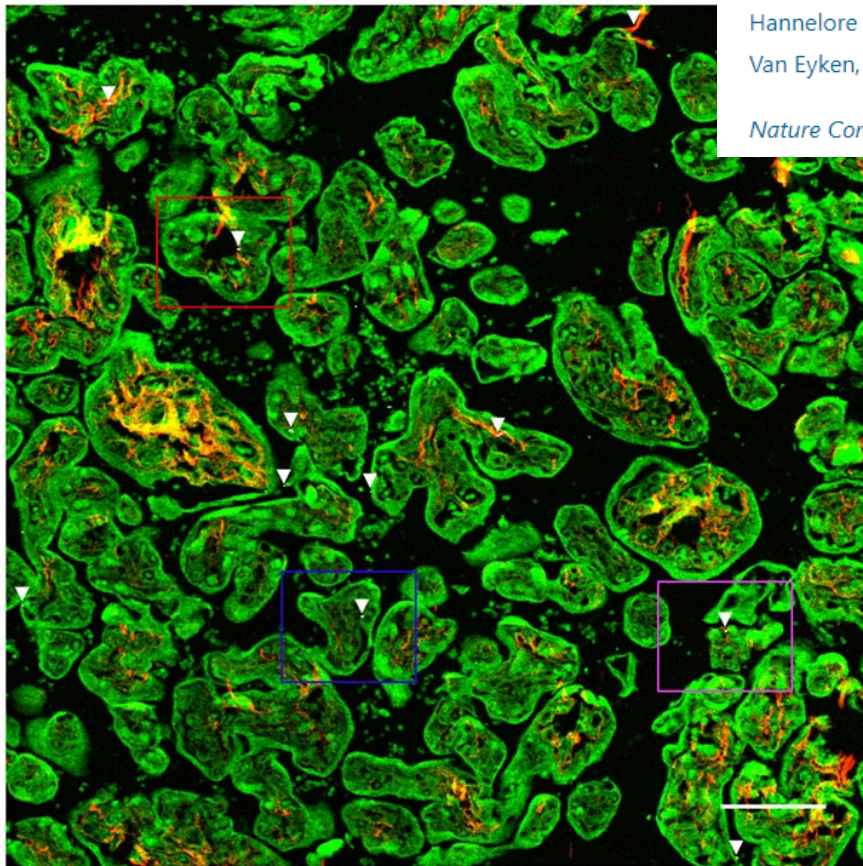


Article | [Open Access](#) | Published: 17 September 2019

Ambient black carbon particles reach the fetal side of human placenta

Hannelore Bové, Eva Bongaerts, Eli Slenders, Esmée M. Bijmens, Nelly D. Saenen, Wilfried Gyselaers, Peter Van Eyken, Michelle Plusquin, Maarten B. J. Roeffaers, Marcel Ameloot & Tim S. Nawrot 

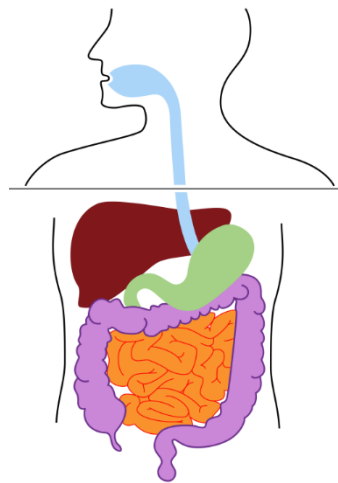
Nature Communications **10**, Article number: 3866 (2019) | [Cite this article](#)



Topics to cover

- Lessons-learned form engineered nanoparticles
- Biomolecular corona?
- Novel approaches in human risk assessment
- Critical points

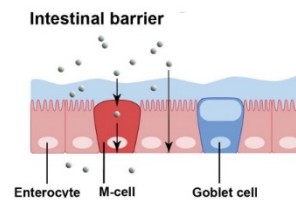
When is a nanoplastic toxic?



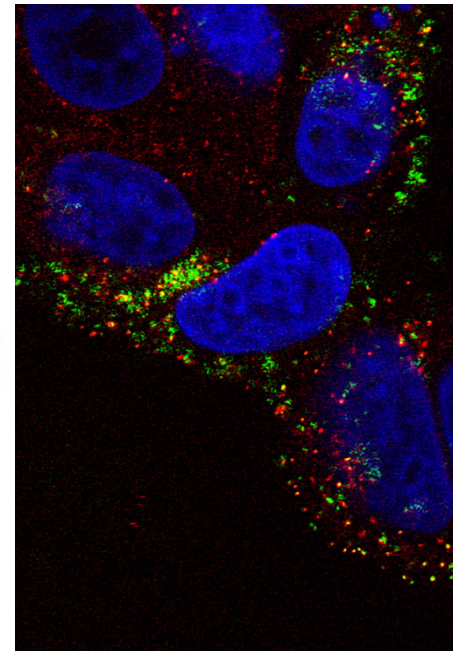
Exposure



Fate during digestion

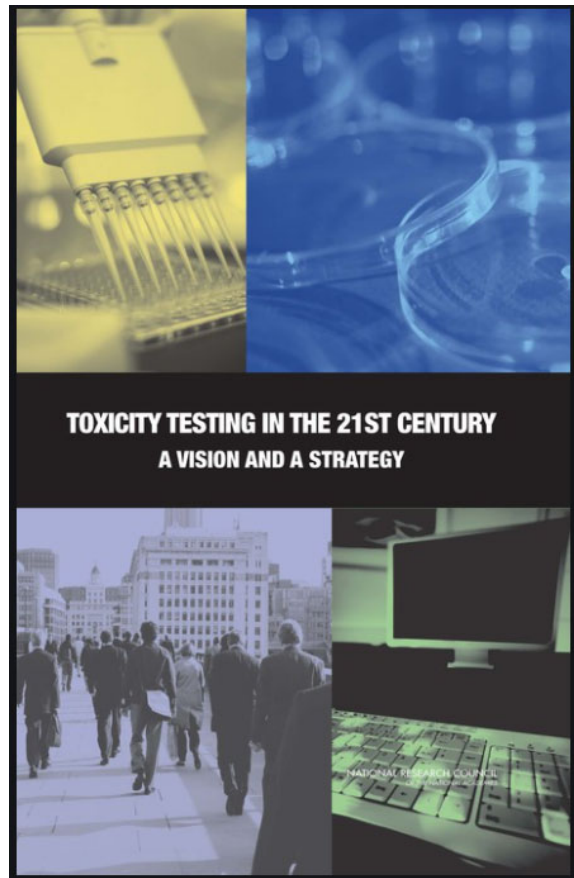


Absorption



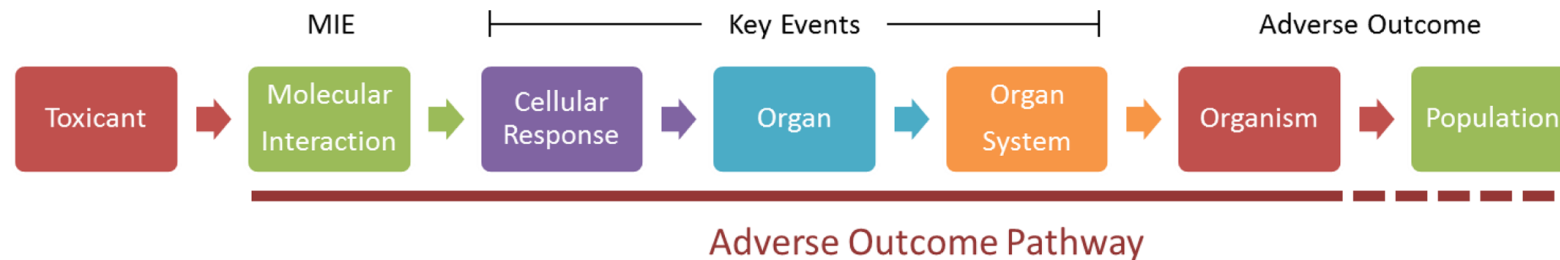
Cellular uptake

Novel approaches for testing <-> material diversity



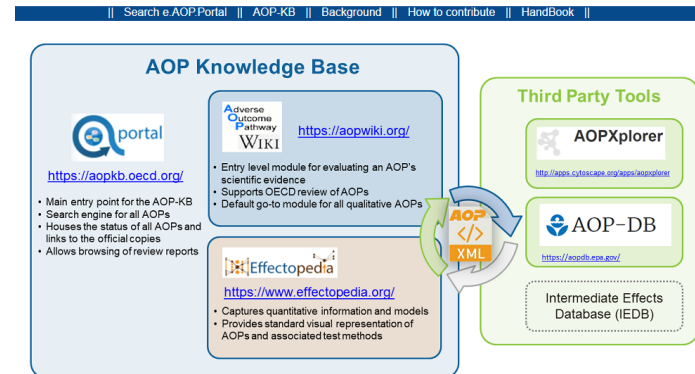
Microplastics EP

A mechanistic approach to understand toxicity



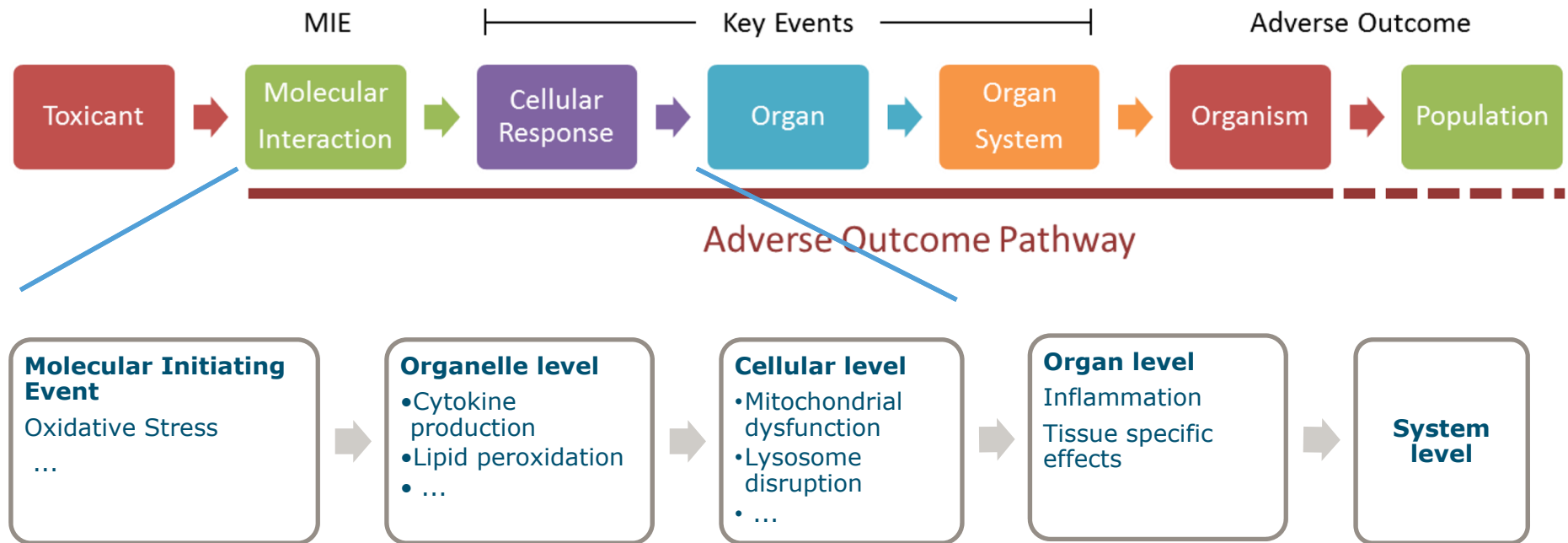
- An Adverse Outcome pathway allows to structure the experimental work and to integrate *in vitro* assays
- An AOP is 'blind' to the chemical of interest: it focusses on the biological effect

Adverse Outcome Pathway Knowledge Base (AOP-KB)

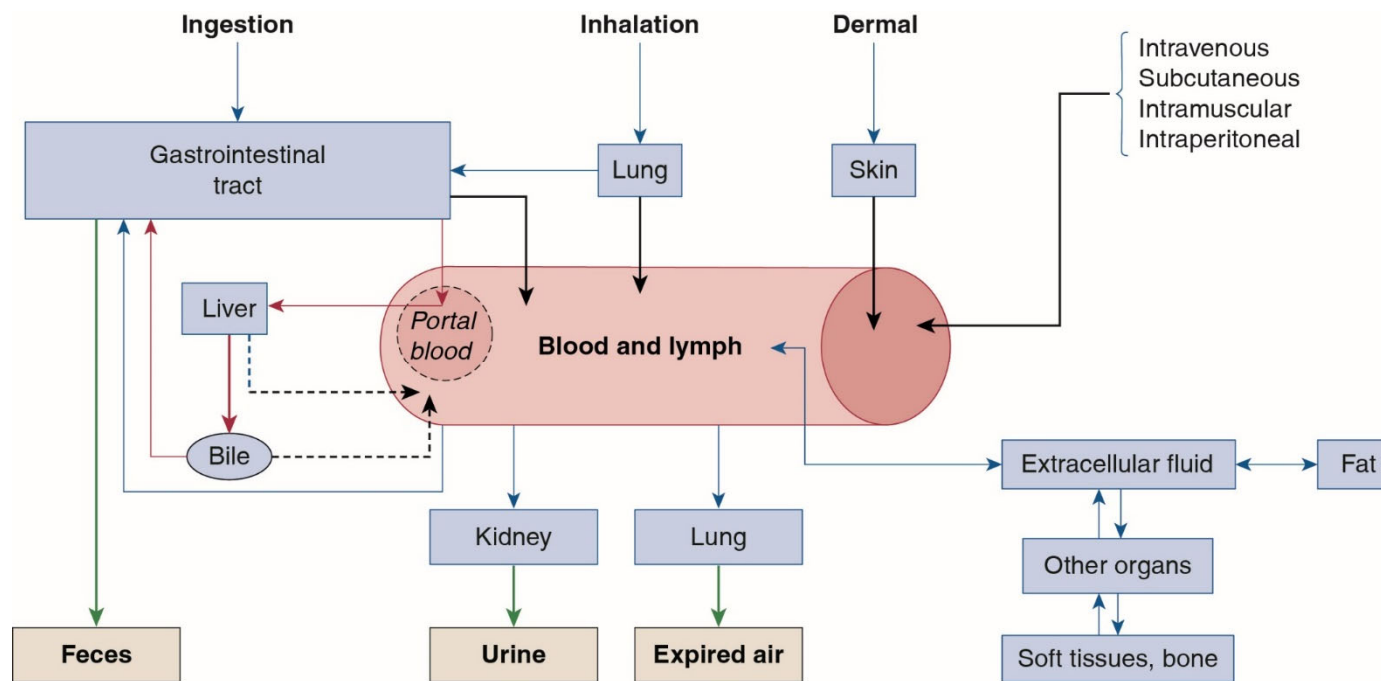


Please click on any of the AOP-KB components or third party modules you want to use.
Please note that the AOP-KB is work in progress and interface updates and more functionality will become available soon.

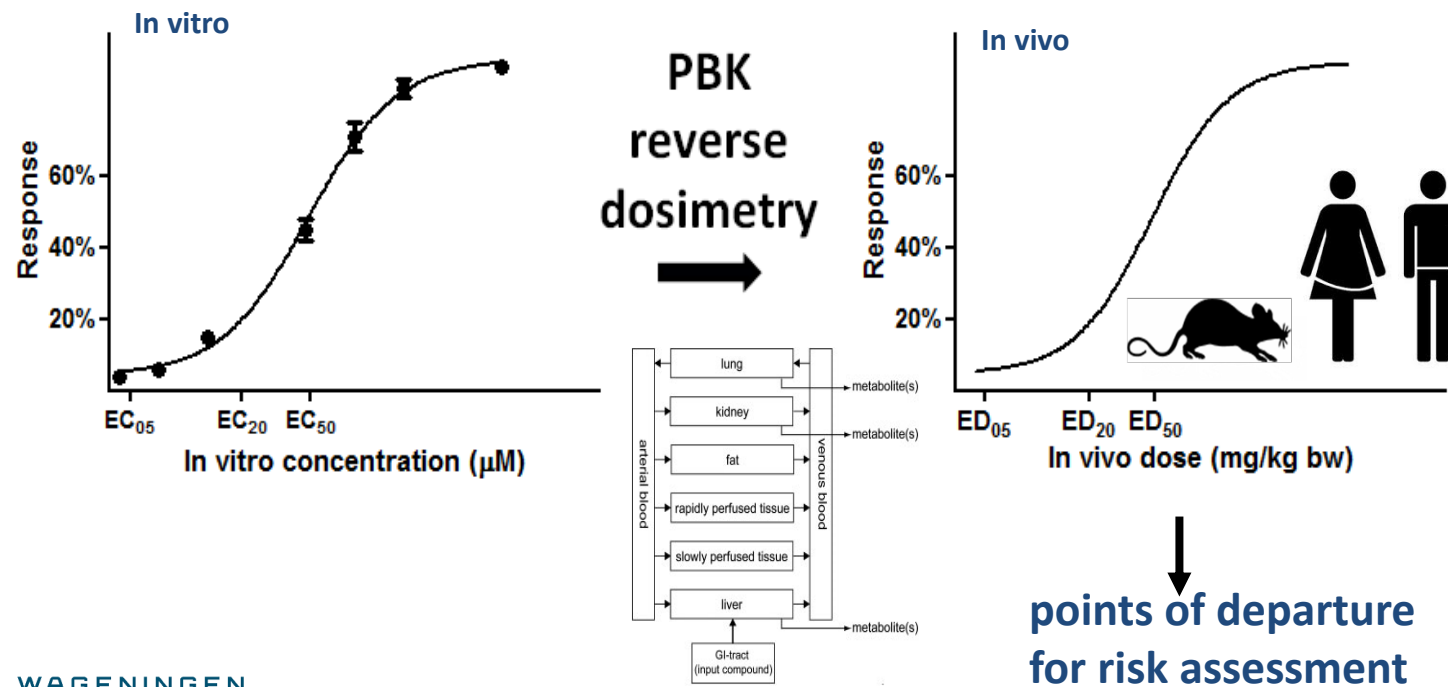
Main AOPs for particles



Systemic fate of nanoplastics (and associated chemicals)



In vitro to in vivo extrapolations: integrate AOP and PBK models



Critical points

- Great diversity in materials
- Need for analytical methods
- Development of particle kinetic models (toxicokinetics)
- Which in vitro approach/model to use?
 - Cell line; stem cell-based; organ-on-chip models (toxicodynamics)
- Extrapolation from in vitro to in vivo
- Point of departure (Benchmark Dose Modelling) for Risk Assessment