


Uptake of orally ingested polystyrene microplastic particles *in vitro* and *in vivo*

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Latest developments

 Environmental Pollution
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Microplastic and mesoplastic pollution in farmland soils in suburbs of Shanghai, China ☆

Mengting Liu ^{a,1}, Shibo Lu ^{a,1}, Yang Song ^a, Lili Lei ^a, Jiani Hu ^a, Weiwei Lv ^b, Wenzong Zhou ^b, Chengjin Cao ^a, Huahong Shi ^c, Xiaofeng Yang ^d, Defu He ^{a, e}

 nature COMMUNICATIONS

ARTICLE

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River plastic emissions to the world's oceans

Laurent C.M. Lebreton^{1,2}, Joost van der Zwet³, Jan-Willem Damsteeg¹, Boyan Slat¹, Anthony Andrady⁴ & Julia Reisser¹

SC
OF

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The occurrence of microplastics (MPs) in saltwater bodies is relatively well studied about their presence in most of the commercial salts that are widely consumed globe. Here, we extracted MP-like identification of their polymer composition in one brand while others contained b

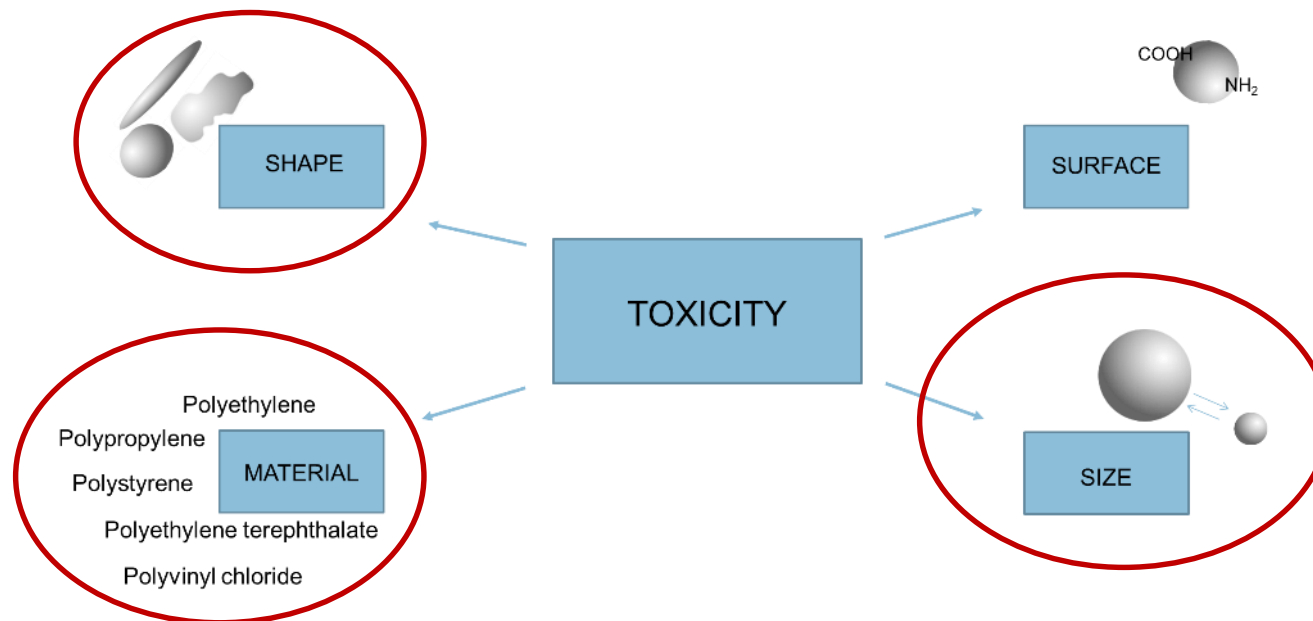
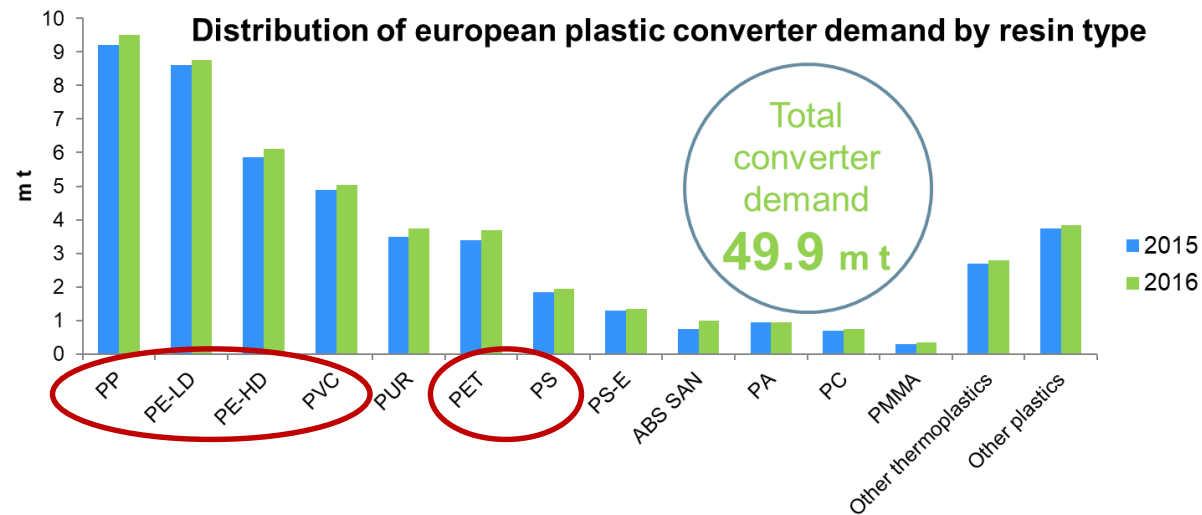
Ubiquitous exposure to microfiber pollution in the air*

Effects on human health?

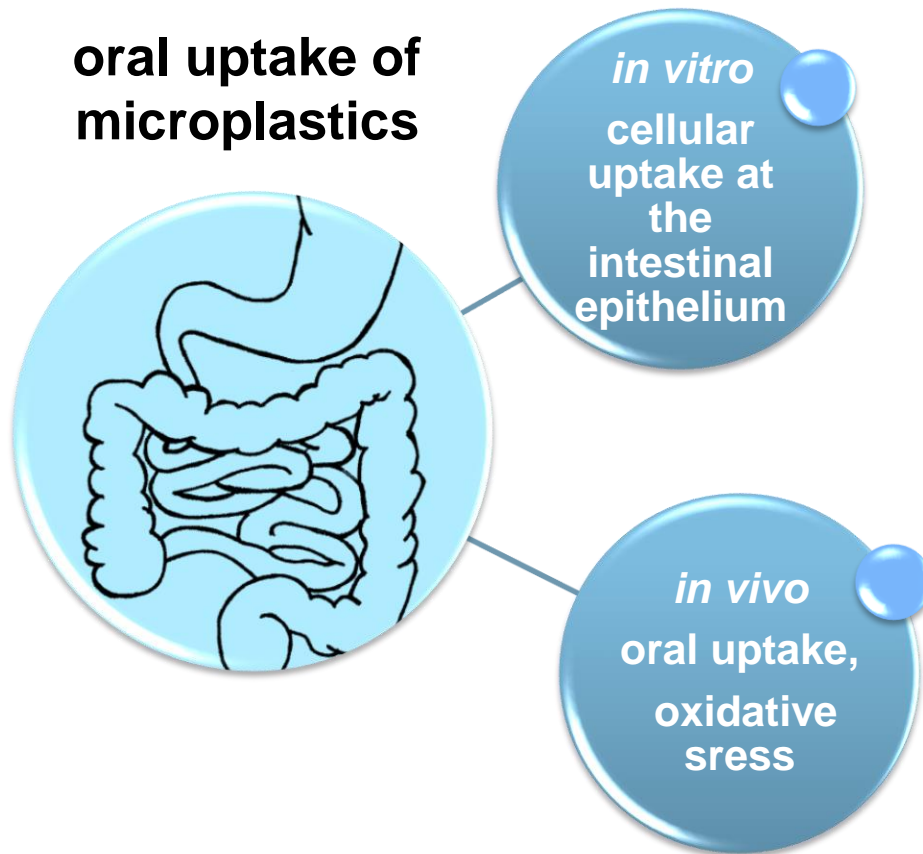
Bettina Liebmann¹, Sebastian Köppel¹, Philipp Königshofer², Theresa Bucsecs², Thomas Reiberger² and Philipp Schwabl²

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Plastics and microplastics

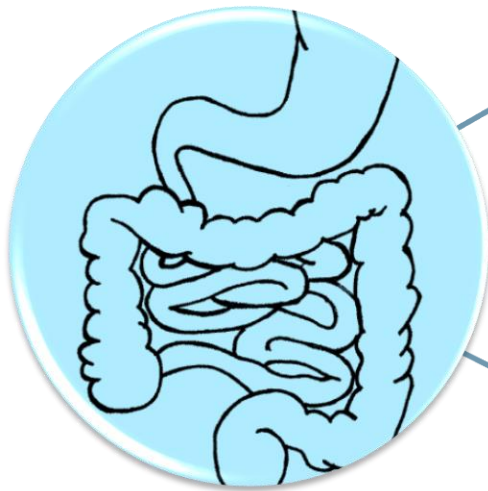


Uptake and effects of microplastics following ingestion



Study design

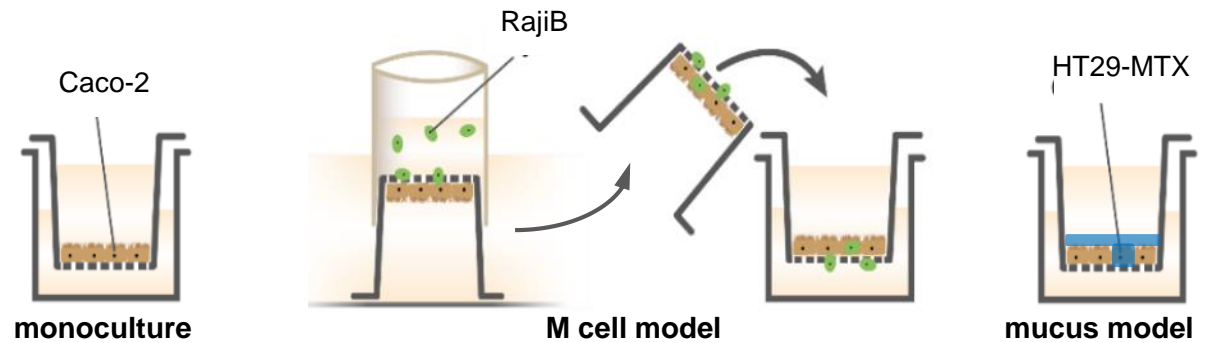
oral uptake of microplastics



in vitro
cellular uptake at the intestinal epithelium

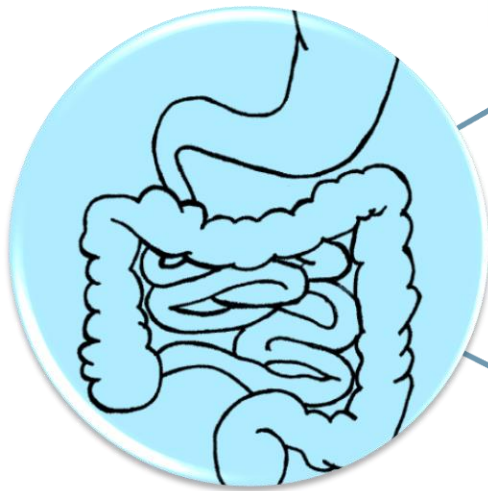
in vivo
oral uptake, oxidative stress

Caco-2 based transwell systems



Study design

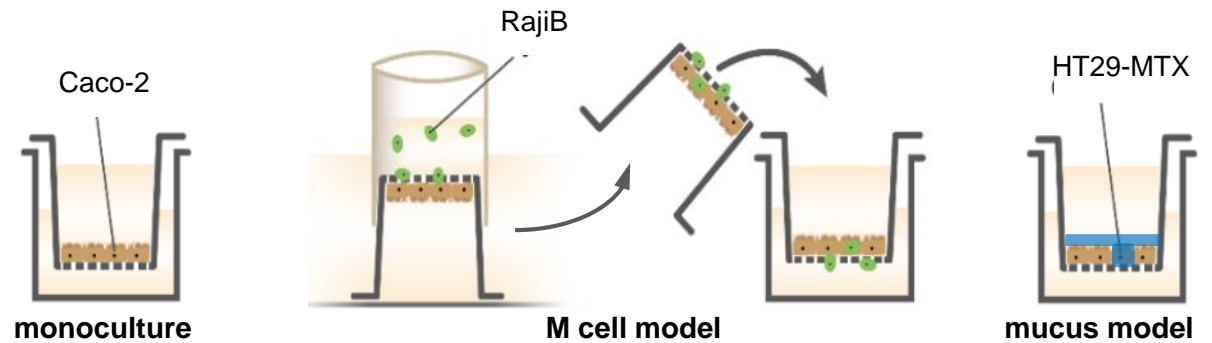
oral uptake of microplastics



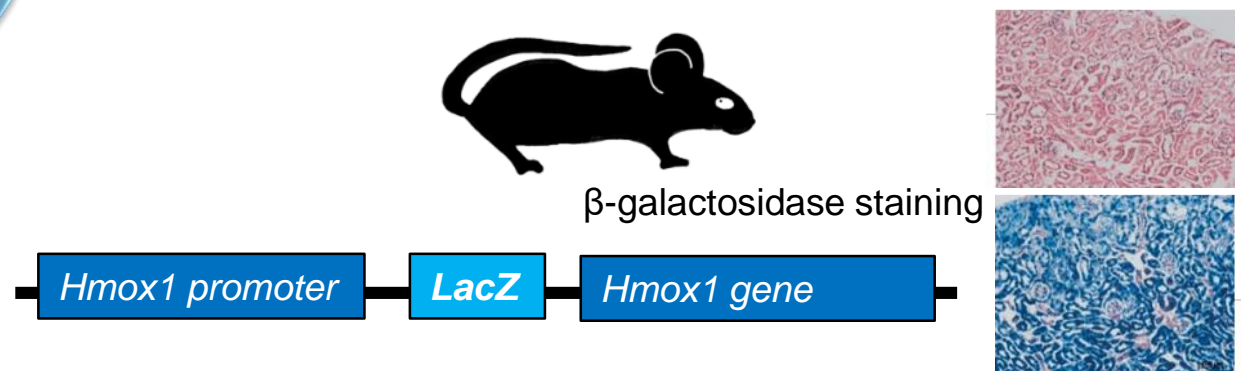
in vitro
cellular uptake at the intestinal epithelium

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oral uptake, oxidative stress

Caco-2 based transwell systems

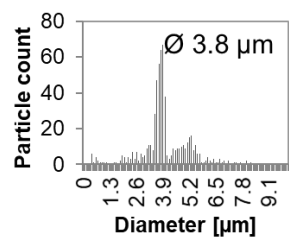
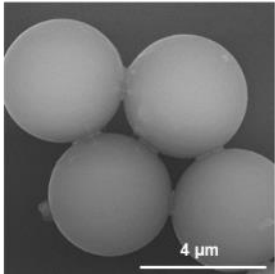


HOTT reporter mice 28-day oral feeding study



Study objects and characterization

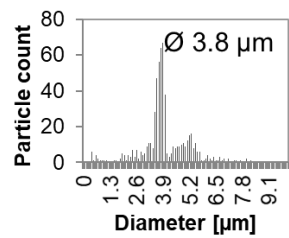
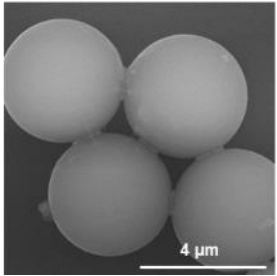
Polystyrene, 1 μm , 4 μm , 10 μm



- Size comparison
- model comparison

Study objects and characterization

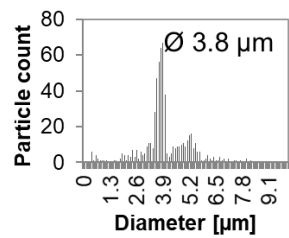
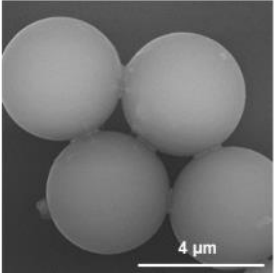
Polystyrene, 1 μm , 4 μm , 10 μm



- Size comparison
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Study objects and characterization

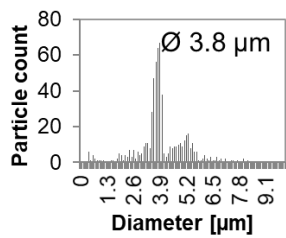
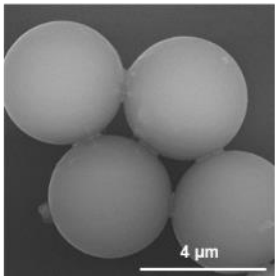
Polystyrene, 1 μm , 4 μm , 10 μm



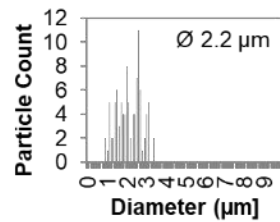
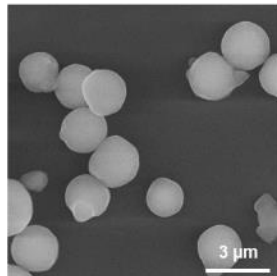
- Size comparison
- model comparison
- In vivo experiment
- cellular effects

Study objects and characterization

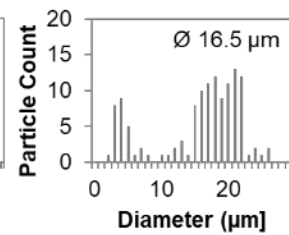
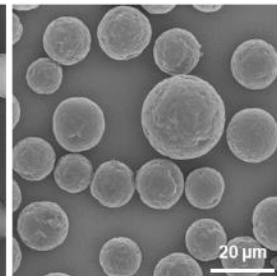
Polystyrene, 1 μm , 4 μm , 10 μm



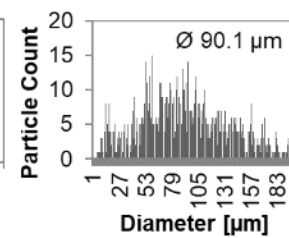
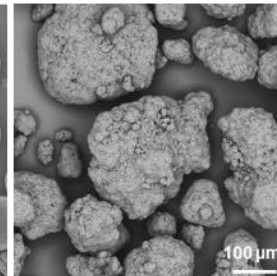
Polyethylene 1-4 μm



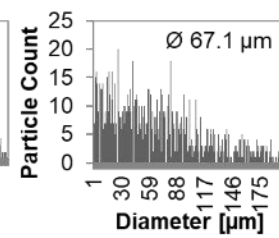
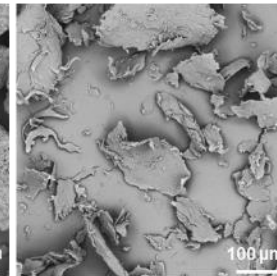
Polyethylene 10-20 μm



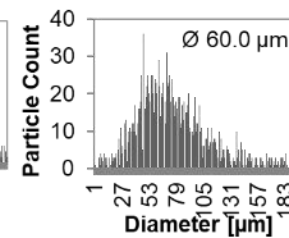
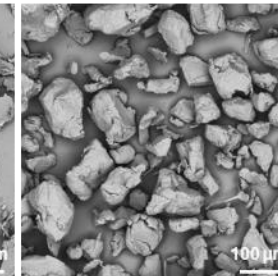
Polyethylene



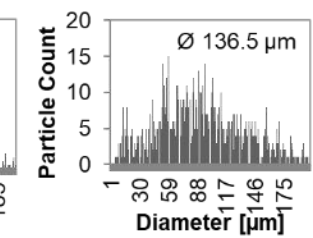
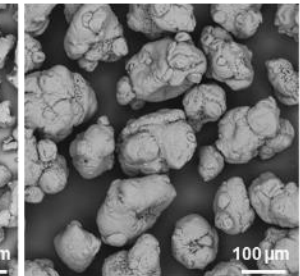
Polypropylene



Polyethylene terephthalate



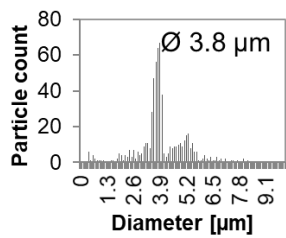
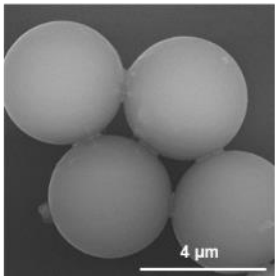
Polyvinyl chloride



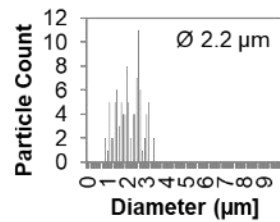
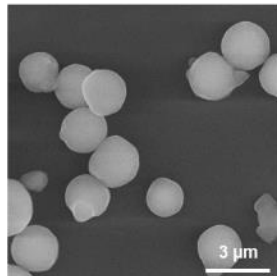
- Size comparison
- model comparison
- In vivo experiment
- cellular effects

Study objects and characterization

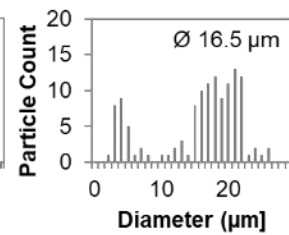
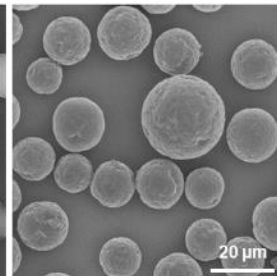
Polystyrene, 1 µm, 4 µm, 10 µm



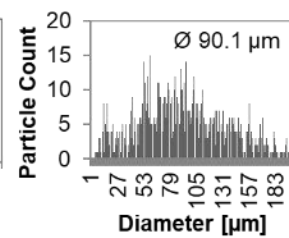
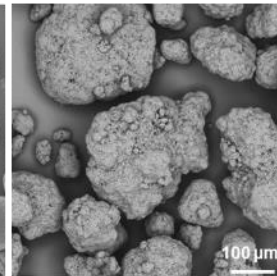
Polyethylene 1-4 µm



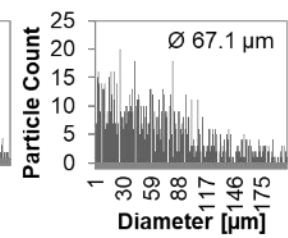
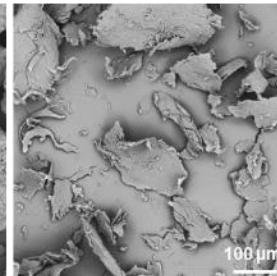
Polyethylene 10-20 µm



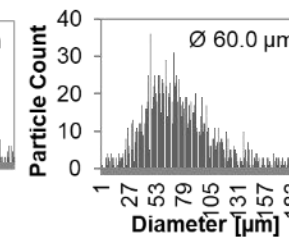
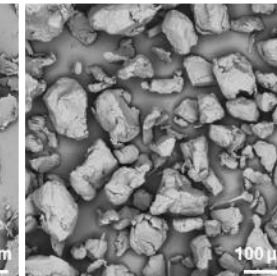
Polyethylene



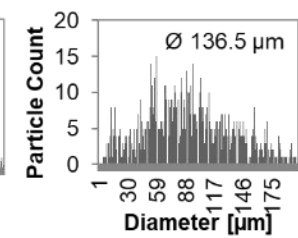
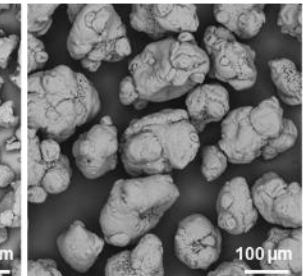
Polypropylene



Polyethylene terephthalate



Polyvinyl chloride



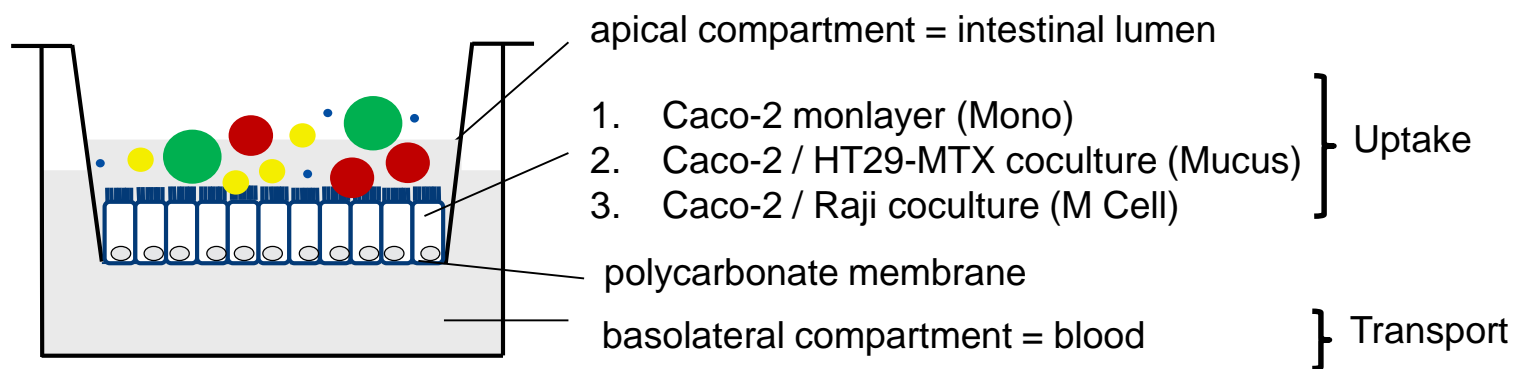
- Size comparison
- model comparison
- In vivo experiment
- cellular effects

→ Material comparison

In vitro uptake - transwell experiments

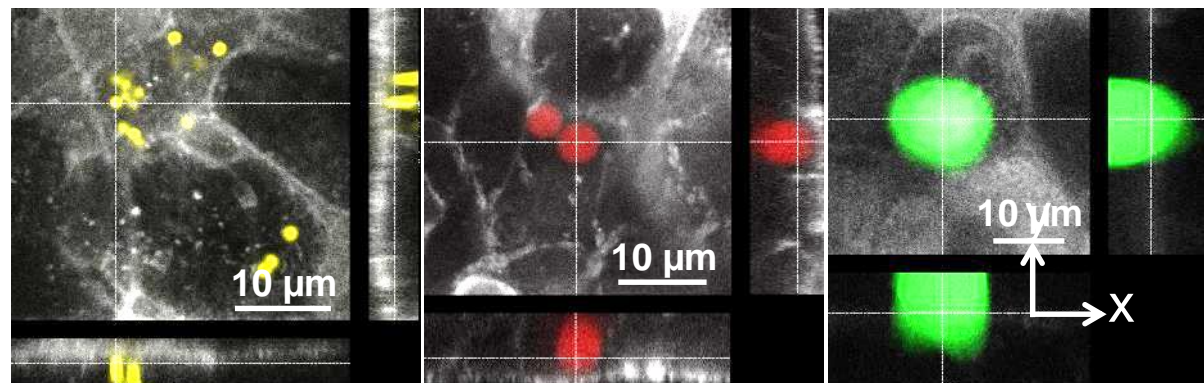
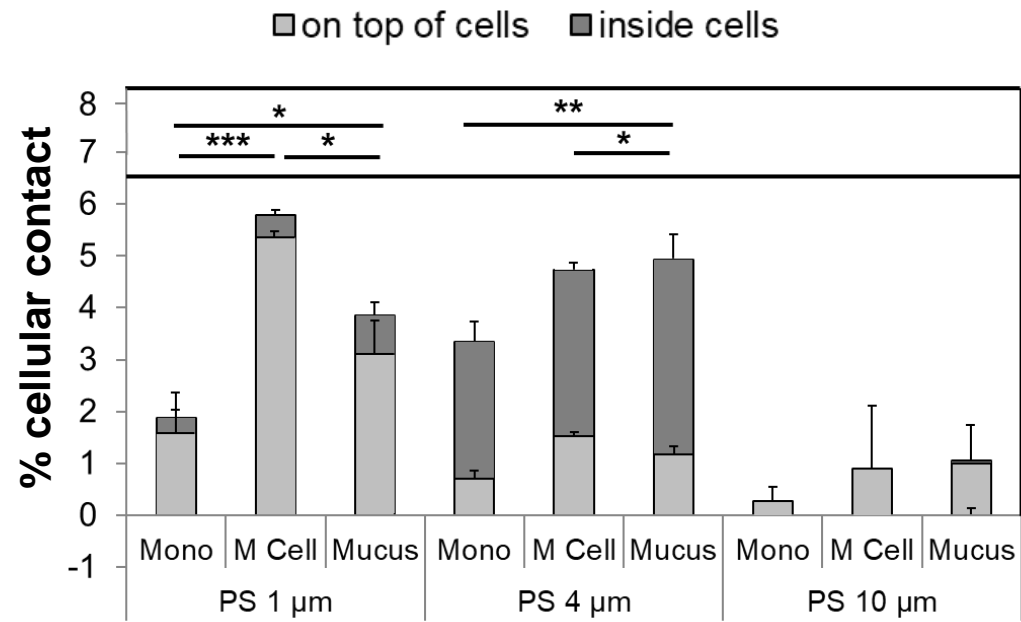
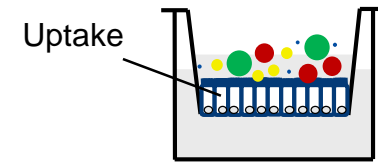


Incubation with high, non-toxic particle concentrations, 24 h

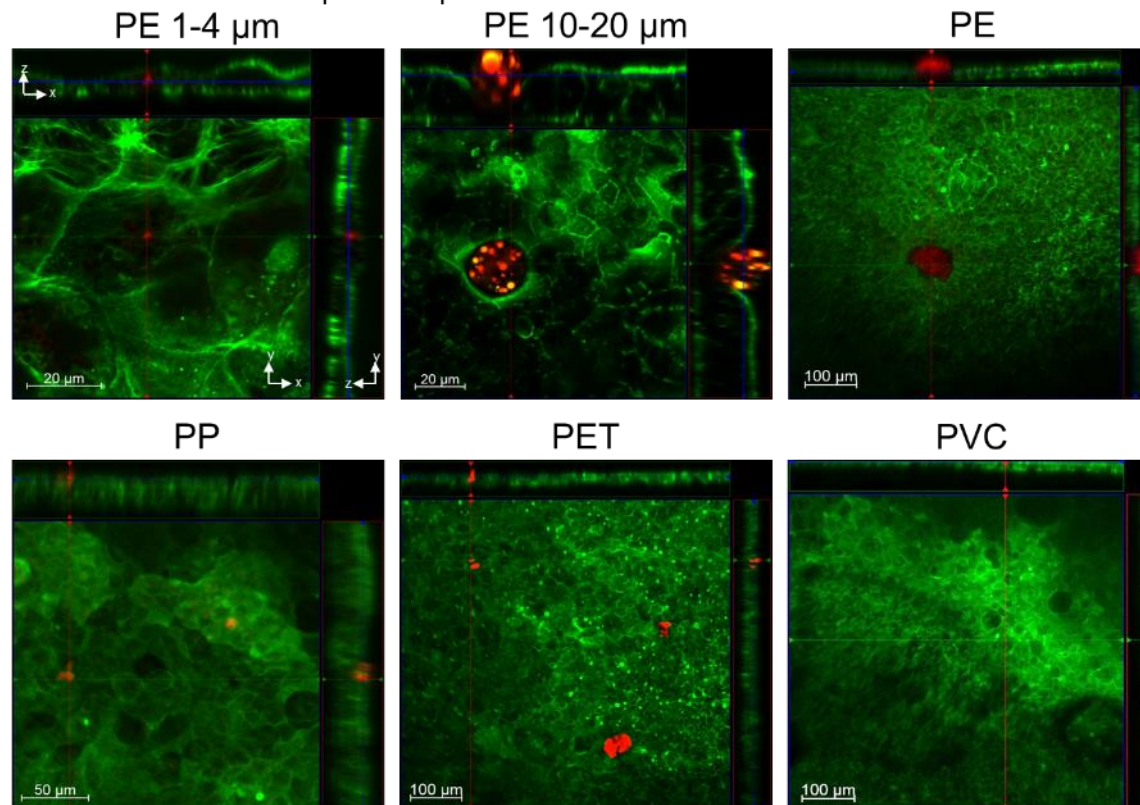
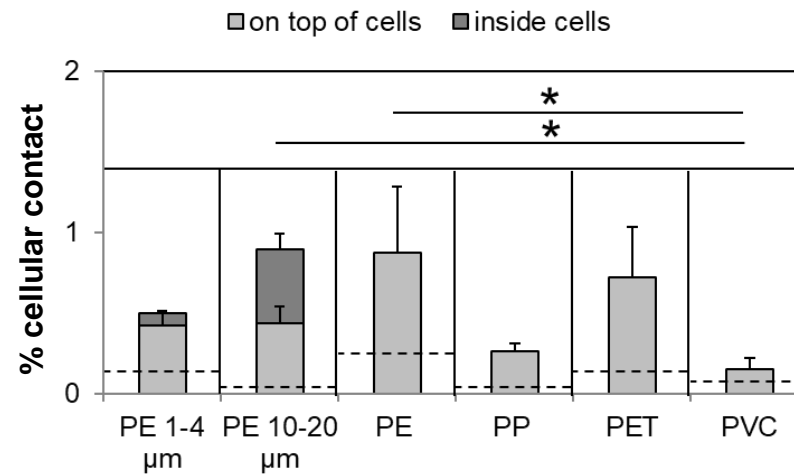
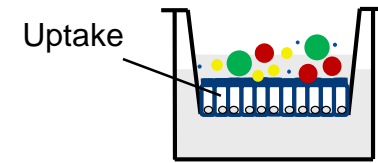


What is the absorption/transport rate of microplastic particles *in vitro*? Is there a size or material dependence?

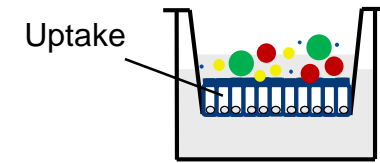
In vitro uptake - transwell experiments with PS



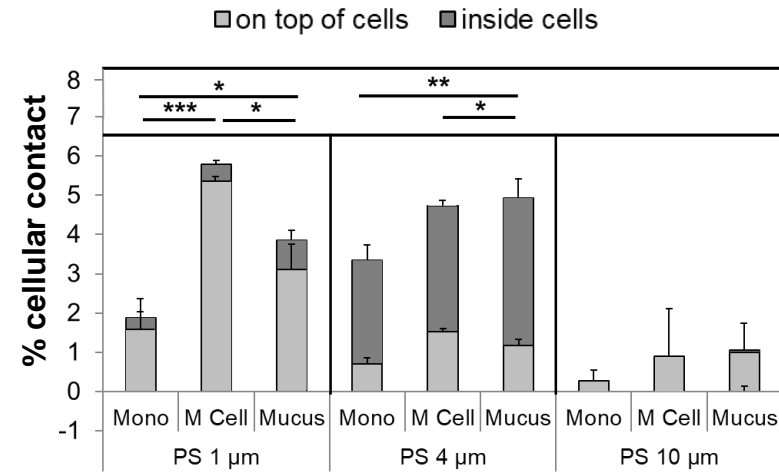
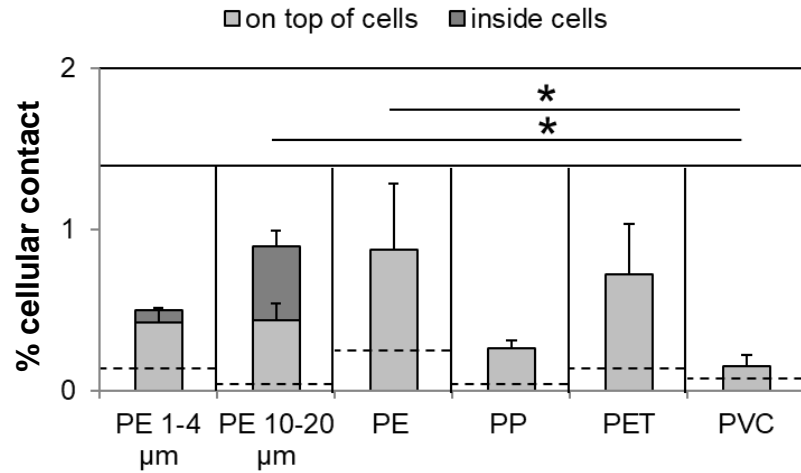
In vitro uptake - transwell experiments with PE, PP, PET and PVC



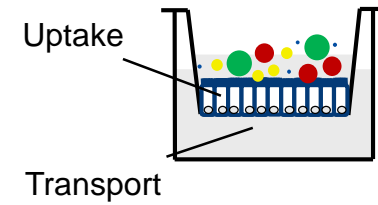
In vitro uptake and transport - transwell experiments



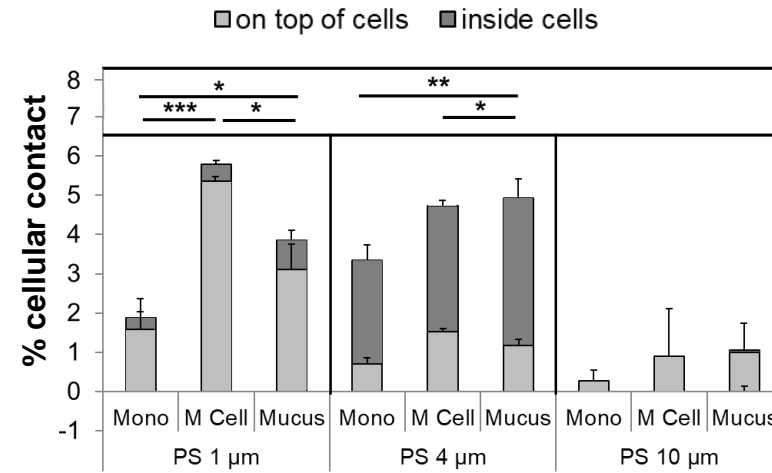
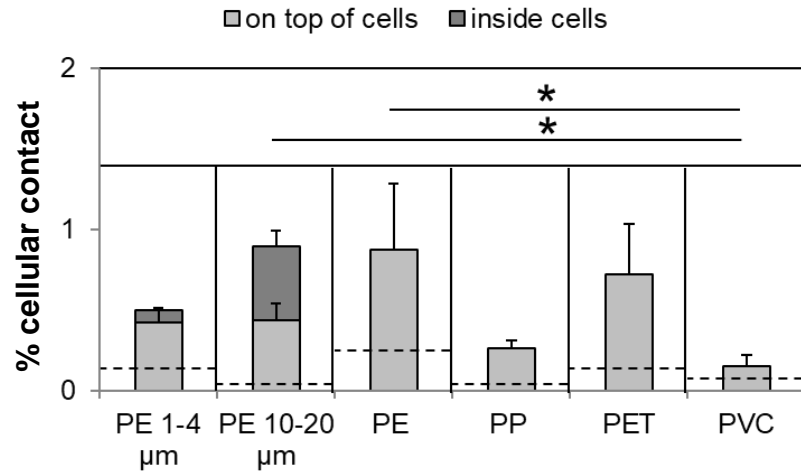
Uptake



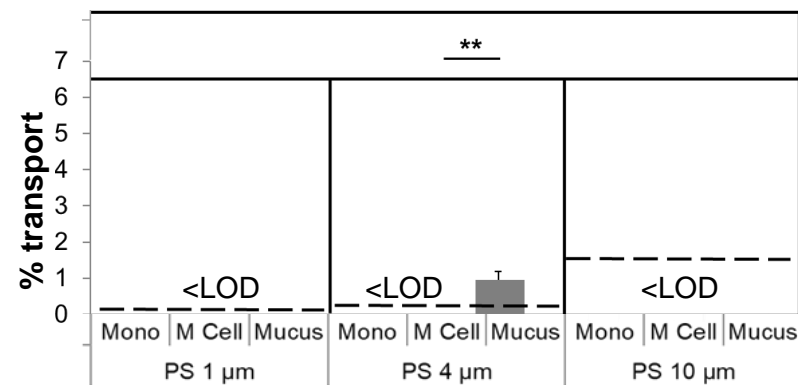
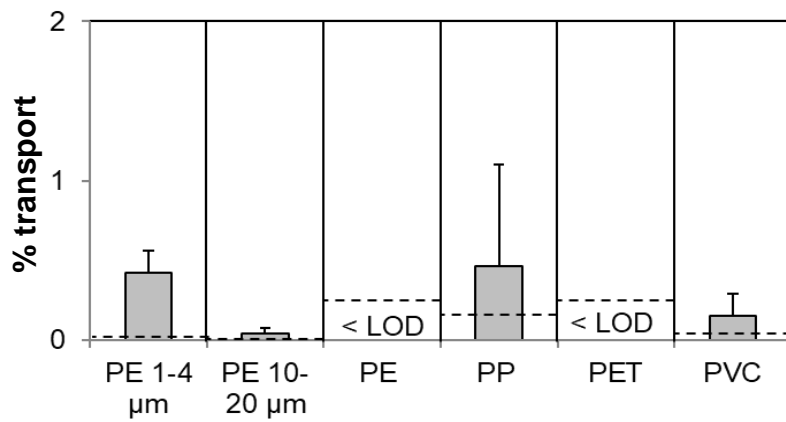
In vitro uptake and transport - transwell experiments



Uptake



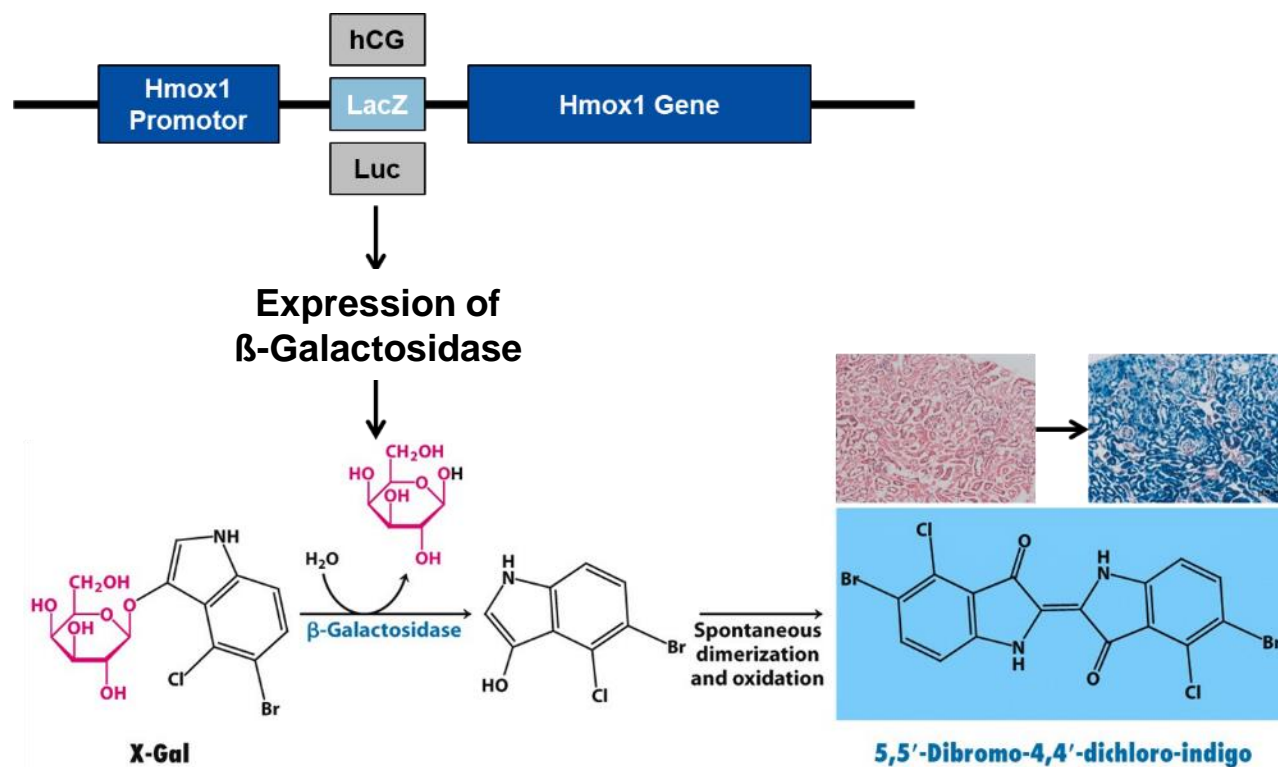
Transport



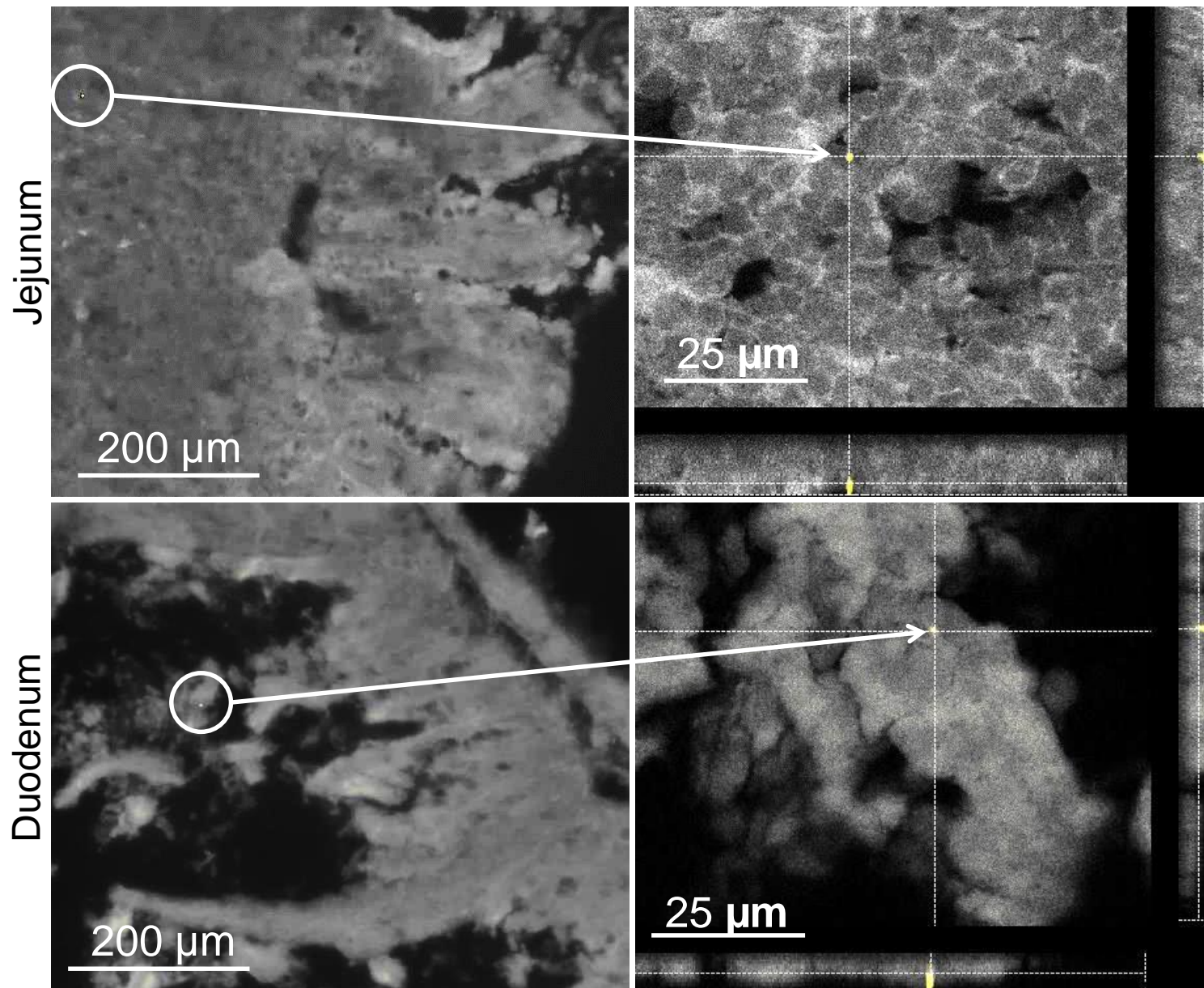
In vivo study



Treatment	Dose [3 x/week]	Number of mice
0.5% (w/v) carboxymethyl cellulose (vehicle)		5
Mixture of 1 μm	4.55 x 10 ⁷ particles	5
4 μm	4.55 x 10 ⁷ particles	
10 μm polystyrene	1.49 x 10 ⁶ particles	



In vivo study - uptake

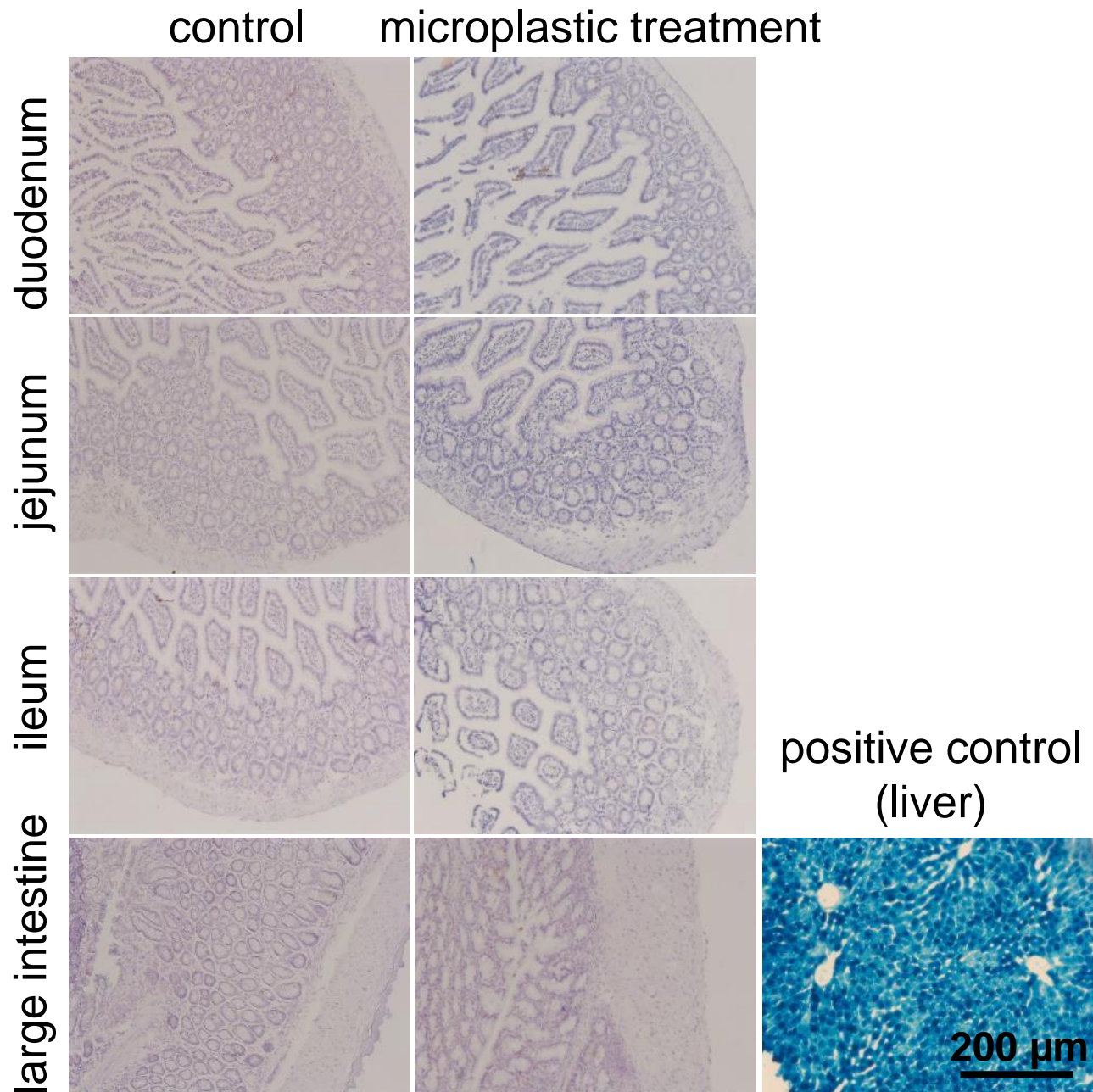


→ Very low particle burden

→ Only 1 µm particles were taken up

→ Uptake limited to the intestine, no particles in other organs

In vivo study - uptake



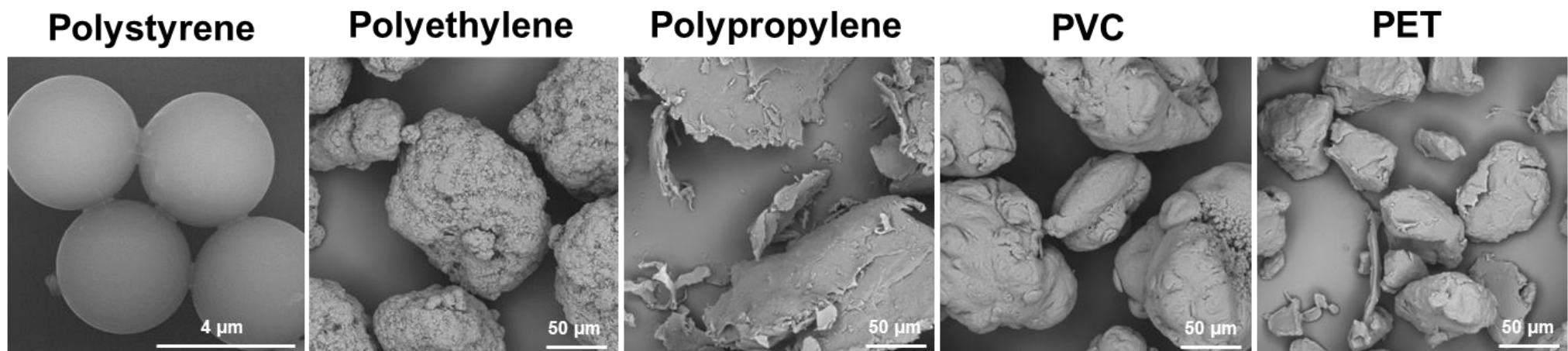
→ No indication of oxidative stress

Summary

- ***In vitro:***
 - Particle uptake increases by use of more complex intestinal models and may be material-dependent
 - Low particle transport
 - Particle uptake and transport are not strictly size-dependent, but rather depend on the combination of cell culture model, particle size and material
- ***In vivo:***
 - Extremely low particle absorption into intestinal cells
 - no particle transport to other organs
 - No indications of oxidative stress

Conclusions

- ***In vitro* intestinal barrier models overestimate particle uptake, but can be used for a hazard ranking**
- ***In vivo* uptake of PS microplastic particles is extremely low**
→ **future studies should rather concentrate on nanoplastic particles or other plastic materials**



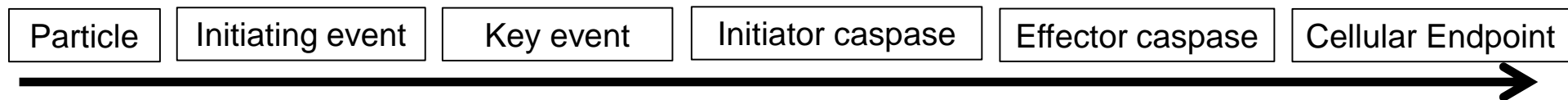
Thank you for your attention

Valerie Stock

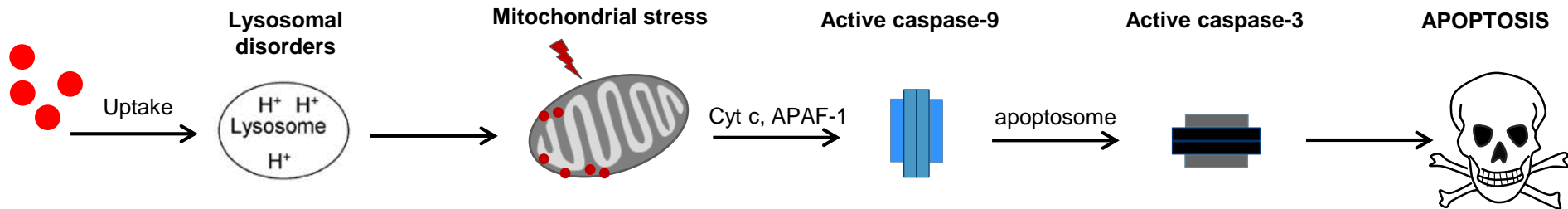


Cellular effects - apoptosis

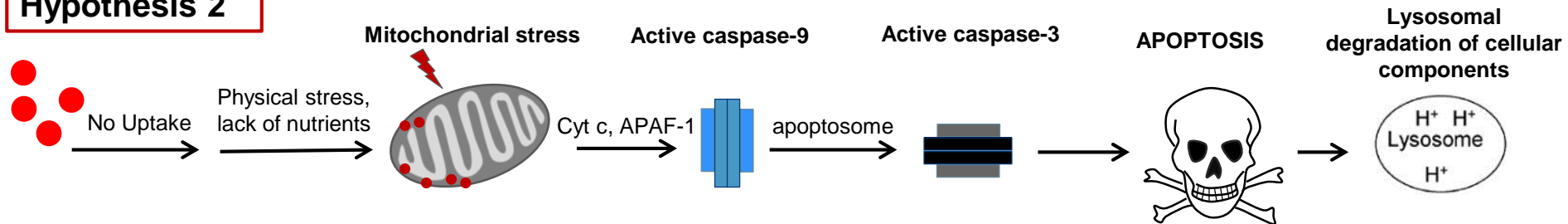
INTRINSIC APOPTOSIS



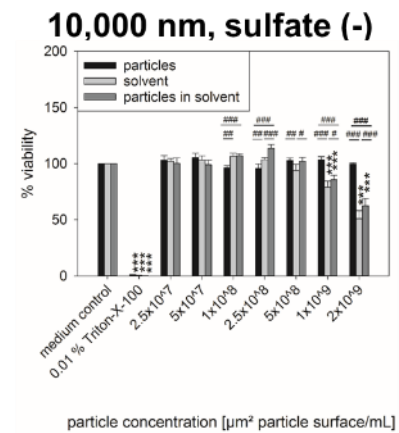
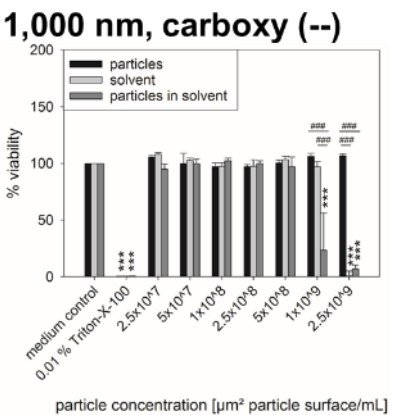
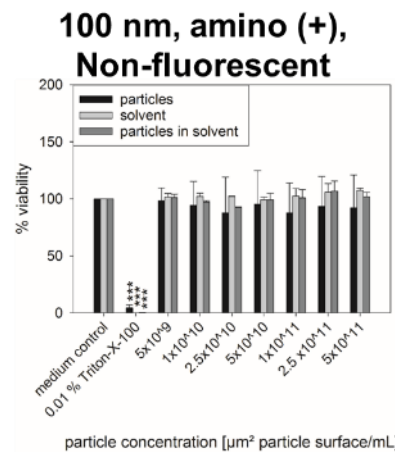
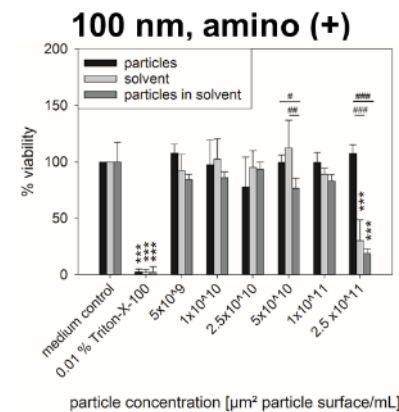
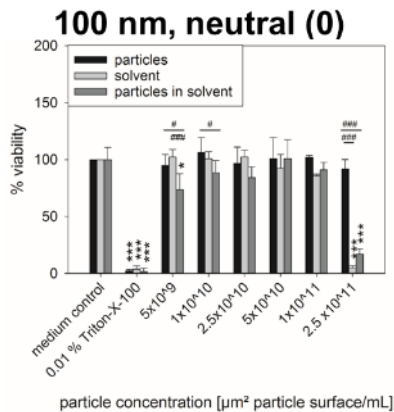
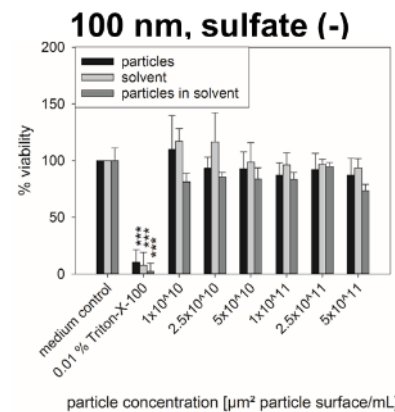
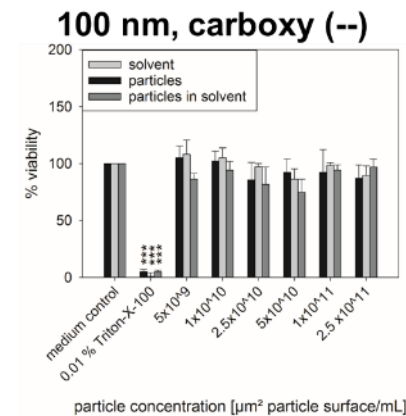
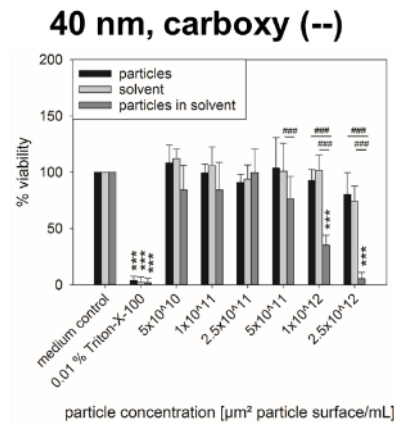
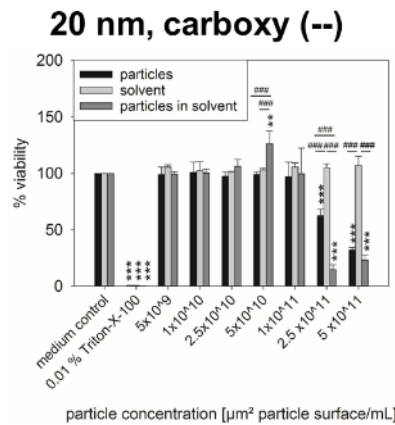
Hypothesis 1



Hypothesis 2

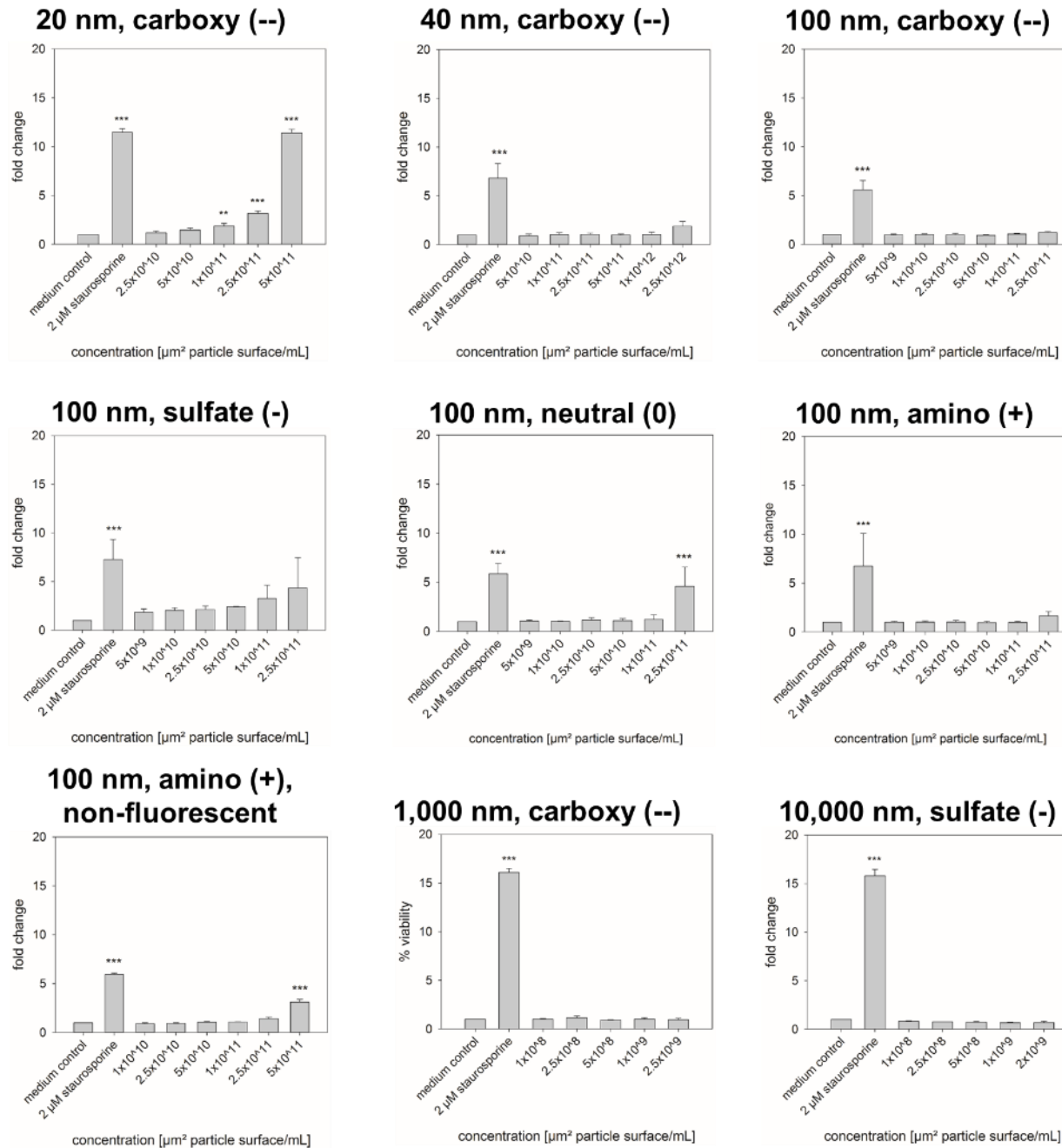


Cellular effects - cytotoxicity

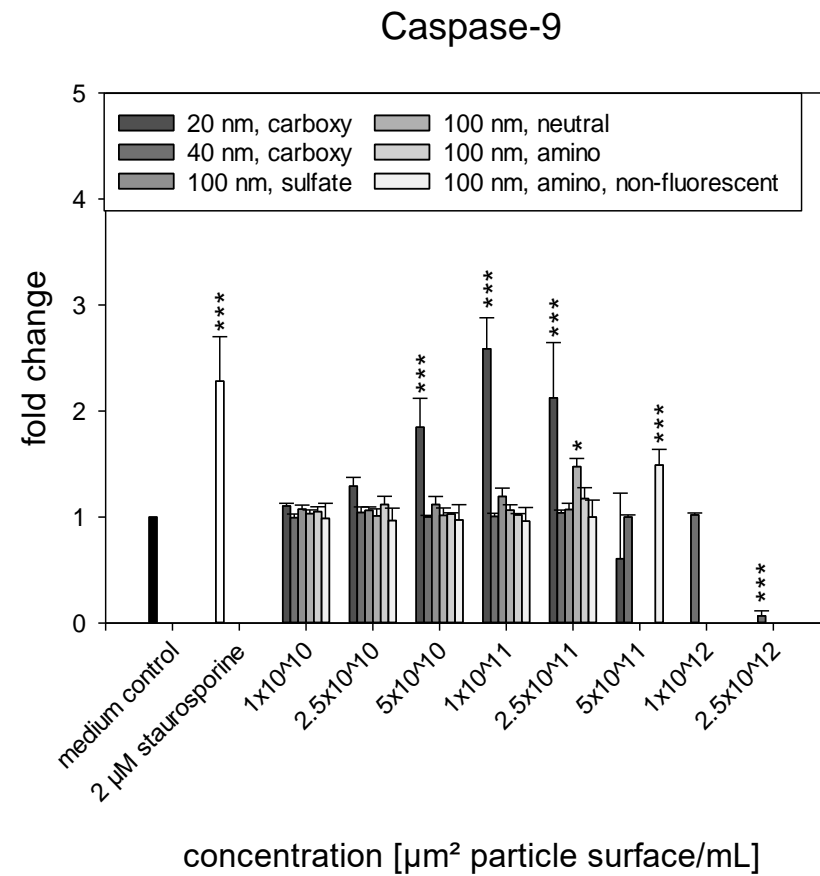
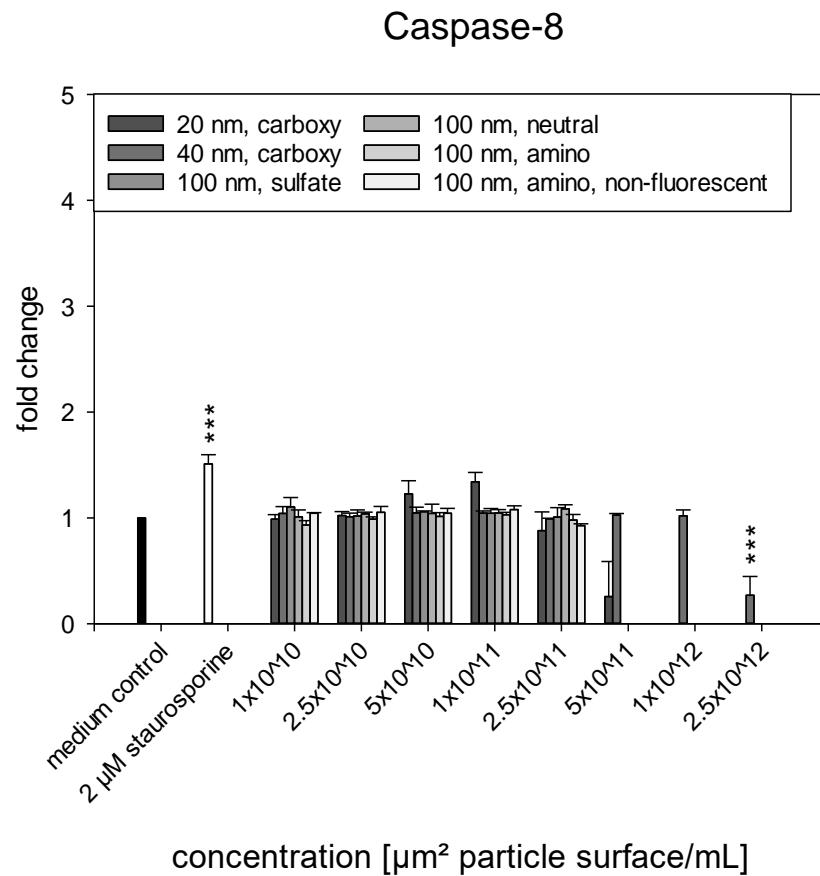


Cellular effects – apoptosis: Caspase-3 activity

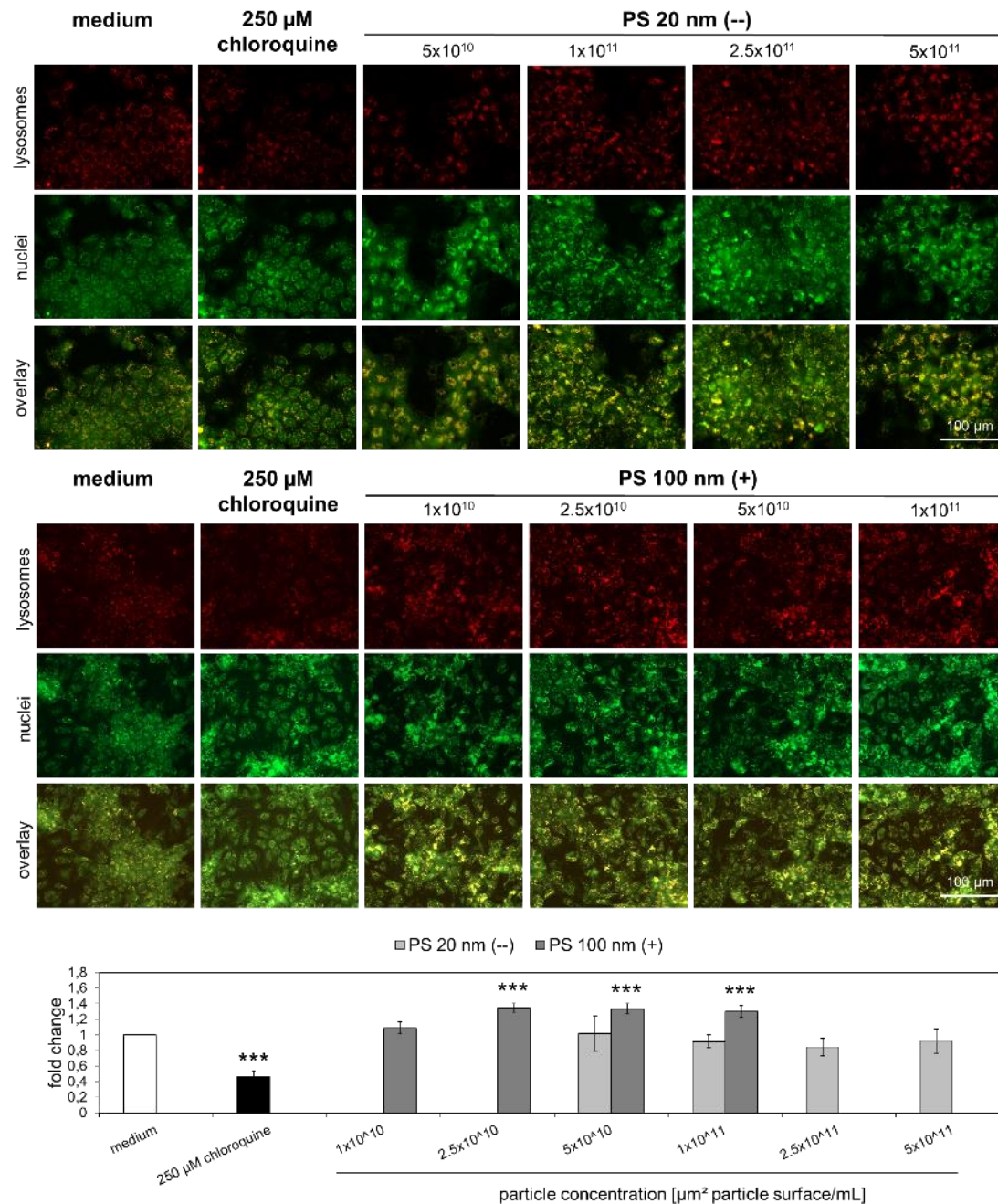
Caspase-3



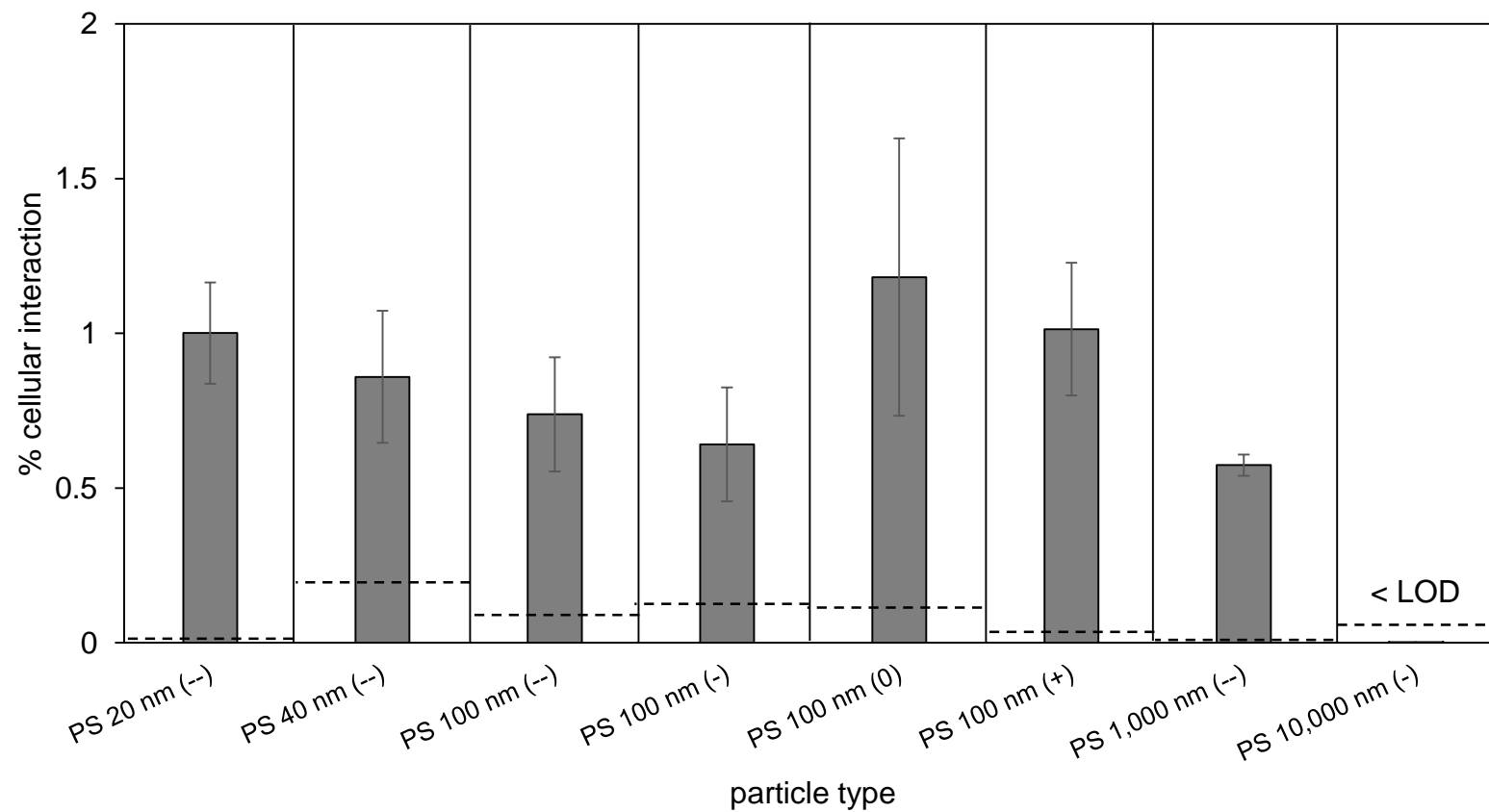
Cellular effects – apoptosis: Caspase-8 and -9 activity



Cellular effects – lysosomal acidification

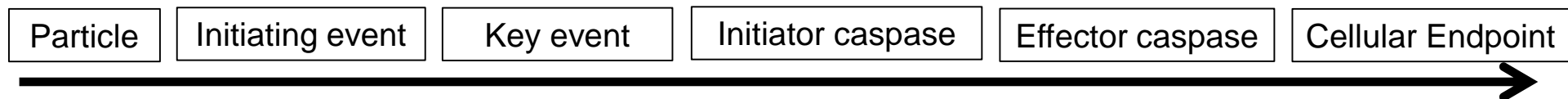


Cellular effects – uptake

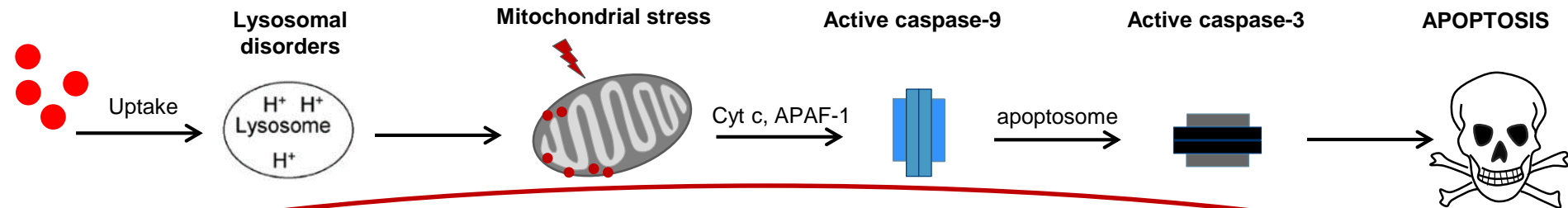


Cellular effects - apoptosis

INTRINSIC APOPTOSIS



Hypothesis 1



Hypothesis 2

