



# Human toxicity of microplastics

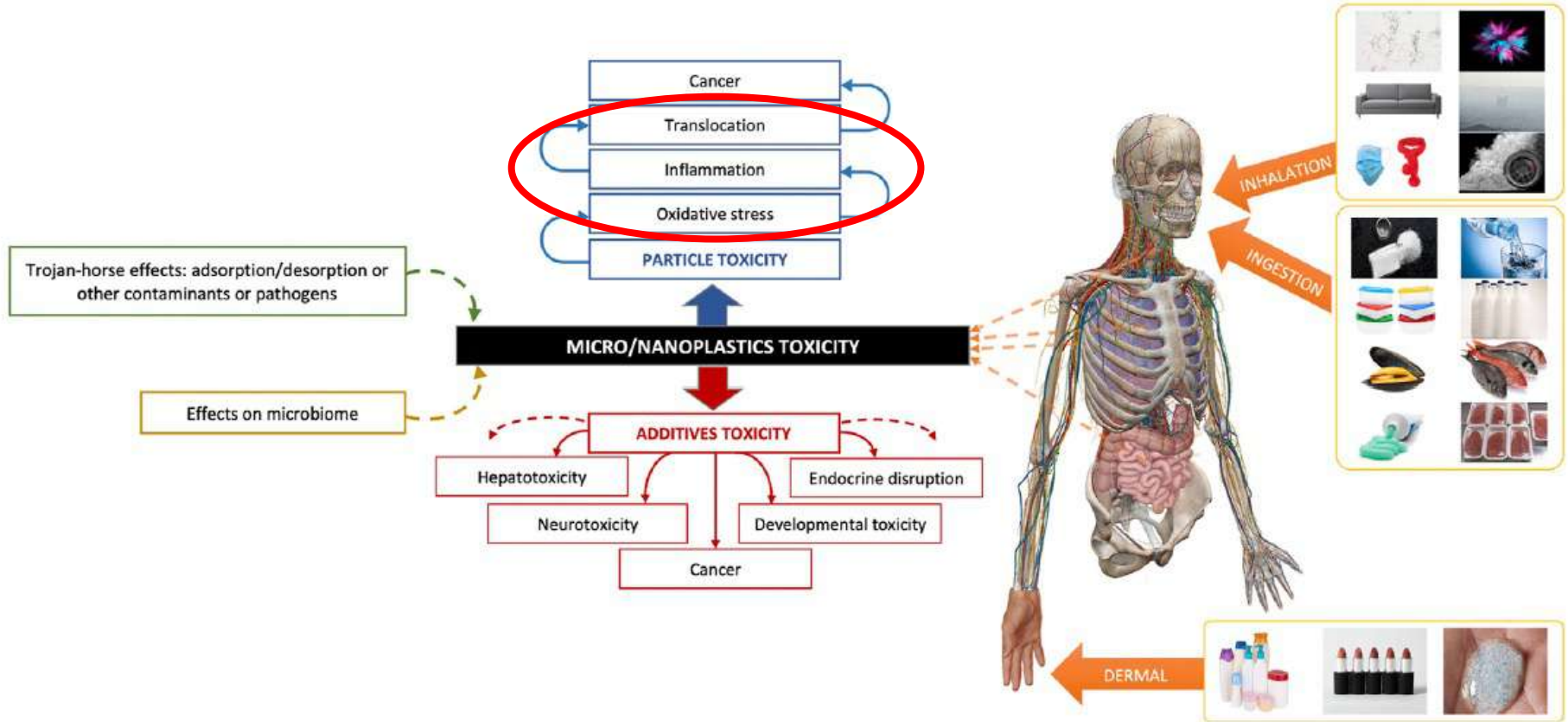
## *Towards a Risk Assessment Framework for Micro- and Nanoplastic*

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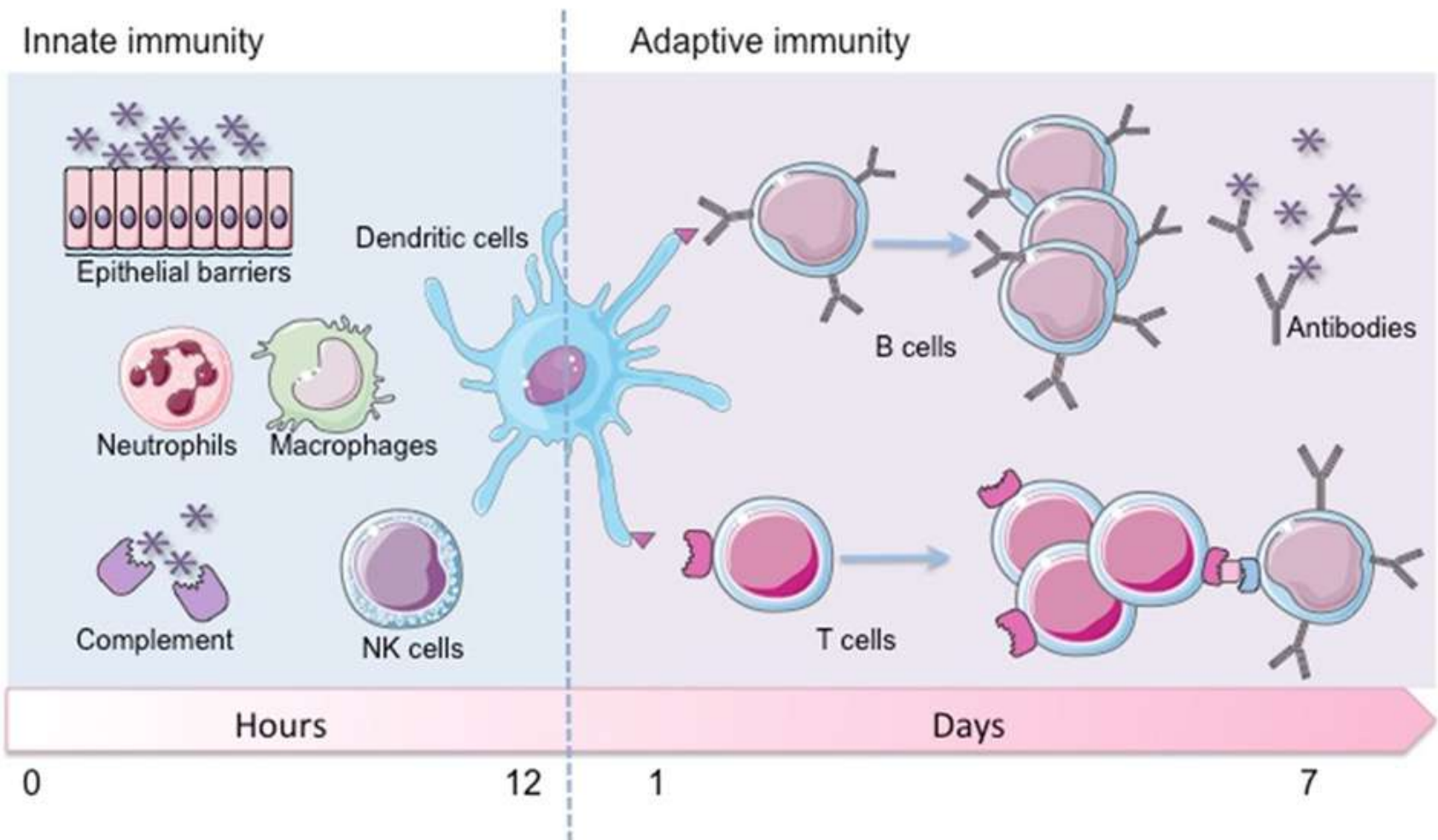


# Potential toxicities and exposure routes of MNP



**FIGURE 1** | Summary of the human routes of exposure to MNPLs and their potential effects on health.

## WHAT ARE KEY EVENTS PREDICTIVE FOR INFLAMMATION?



# Effects of MNP on THP1-macrophages:

- cell viability affected at high [],
- no effect on cytokine production

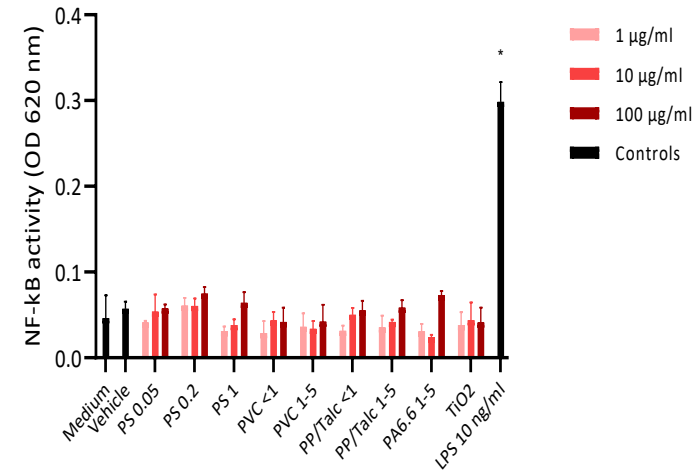
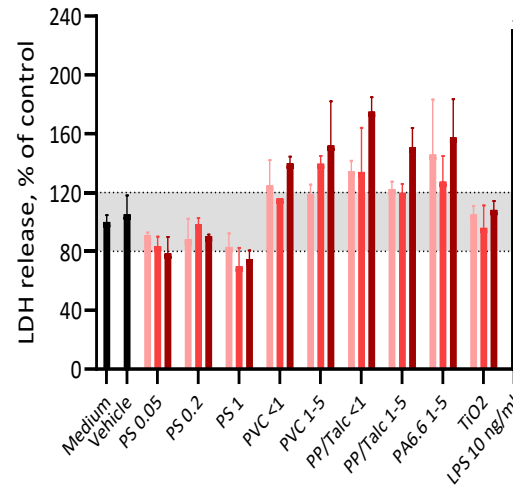
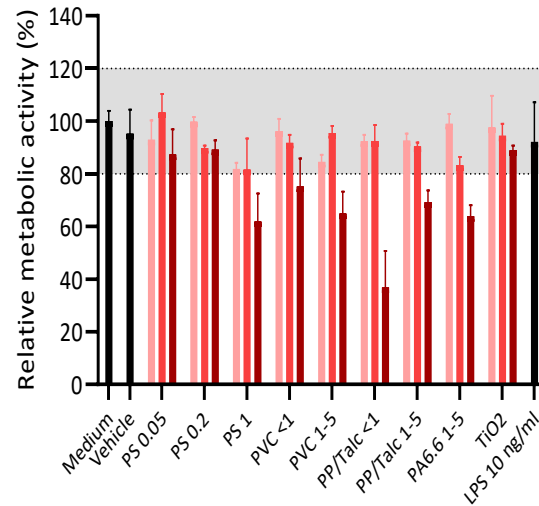


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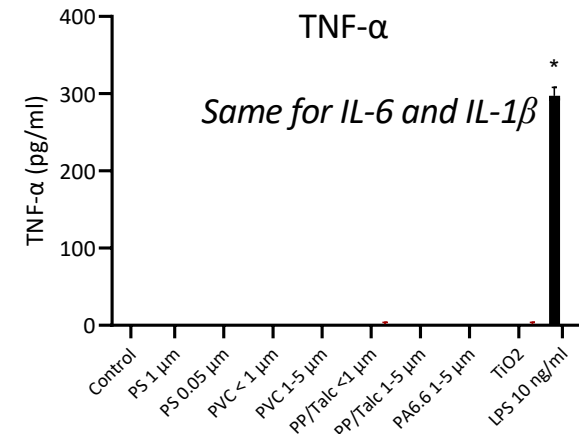
## Mitochondrial activity (alamar blue)

## LDH leakage

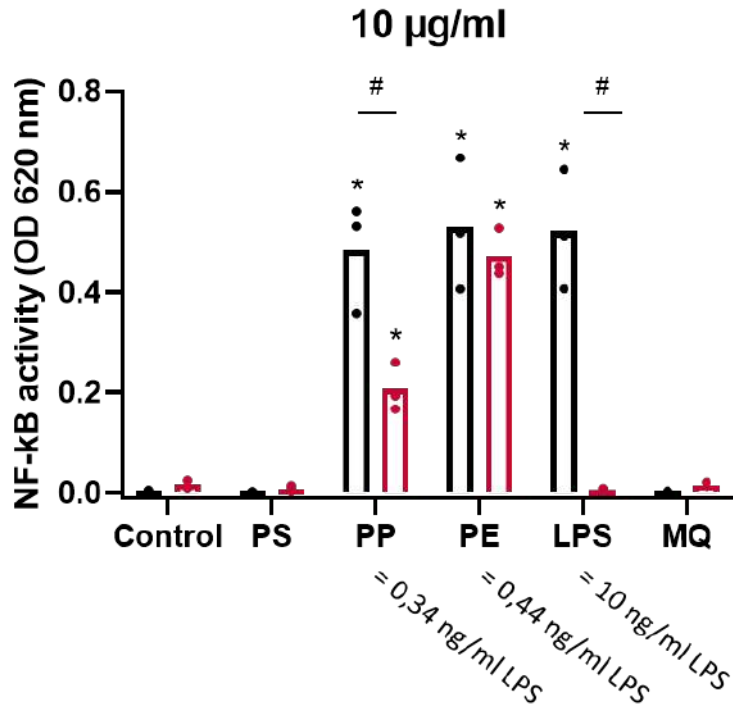
## NF-kB activation



Particle type	Size ( $\mu\text{m}$ )
PS (polystyrene)	0.05, 0.2 and 1
PVC (polyvinylchloride)	<1 and 1-5
PP (polypropylene)/Talc	<1 and 1-5
PA (polyamide/Nylon-6,6)	1-5
TiO <sub>2</sub> (Titanium oxide, reference particle)	0.35
LPS (10 ng/ml, positive control)	



# Effects of aged nano-PE and nano-PP on NF- $\kappa$ B expression by THP1-macrophages



*Similar effects on cytokine production: TNF, IL-6, IL-1 $\beta$*

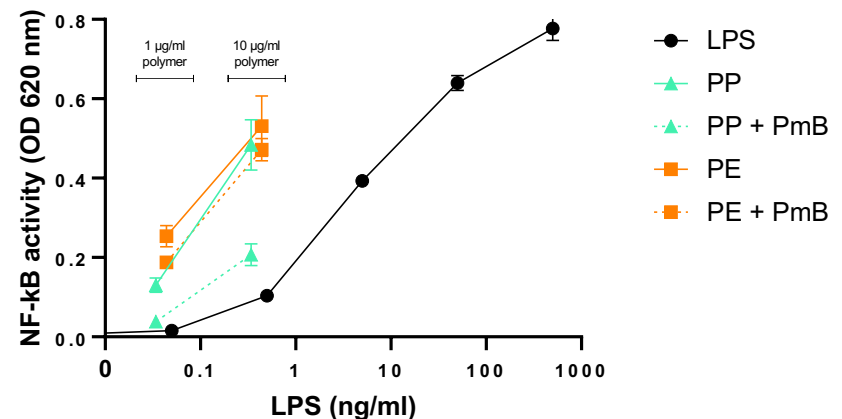
**c=O groups detected on both PP and PE**

XPS data from BAM (Korinna Altmann)

**Estimation of LPS content based on LAL assay**

	Polymer in stock (µg/ml)	LPS in stock (ng/ml)	Exposed polymer concentration (µg/ml)	Exposed LPS concentration (ng/ml)
PP	41	1,404	10	0,34
PE	82	3,598	10	0,44









**Effects on NF $\kappa$ B of PE, PP relative to LPS**

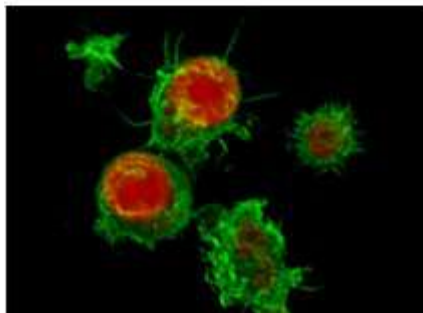
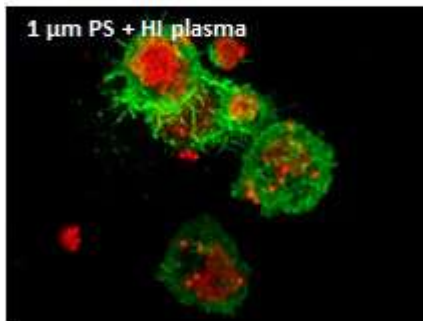
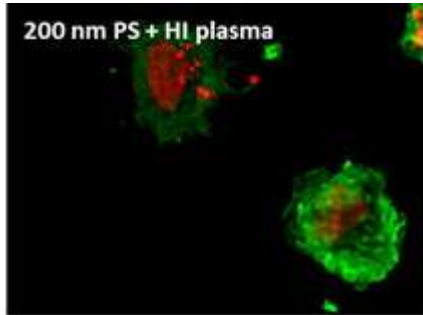


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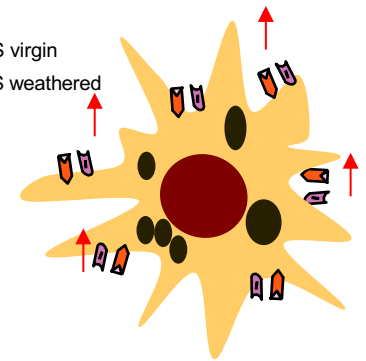
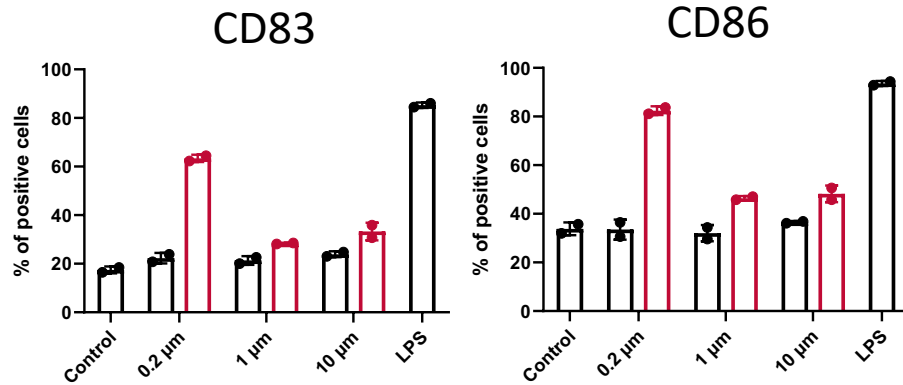
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## Environmentally weathered polystyrene particles induce phenotypical and functional maturation of human monocyte-derived dendritic cells

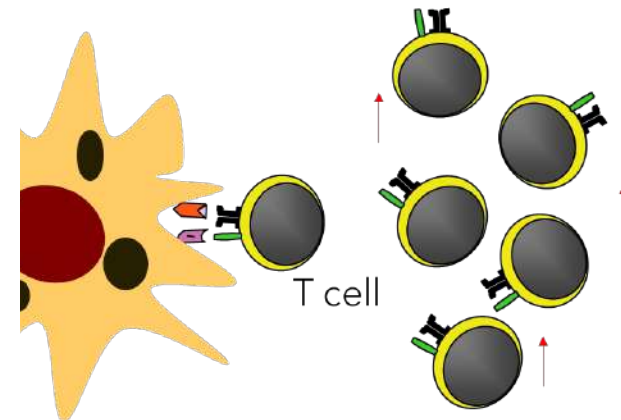
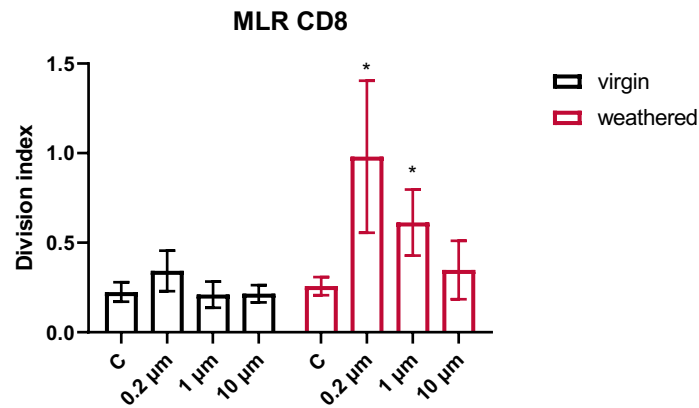
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PS uptake in DCs



Effect of virgin and weathered PS particles on the presence of co-stimulatory molecules on the membrane of MoDCs



Effect of virgin and weathered PS particles on T-cell activation

# POLYRISK's Real World Scenarios

External/internal exposure  
Immune function effects



Air exposure at tire rubber refurbishing workplaces



MNP in bottled drinking water



Utrecht University



Textile fibre workplace exposure



Urban and rural outdoor air ambient MNP



Indoor Soccer Players exposure to rubber granulate-MNP

# MNP in bottled drinking water

- POLYRISK data: 15,000 mp (>1 mm)/l
- New study: 240,000 np/l
- Particles used in in vitro (with THP1 cells):
  - PSP (200nm) 10-100  $\mu\text{g/ml}$ /200,000 cells= 2.3 e9-e10
  - PSP (1  $\mu\text{m}$ ) 10-100  $\mu\text{g}$ =1.8 e7-e10

**PNAS**

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## Rapid single-particle chemical imaging of nanoplastics by SRS microscopy

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and Wei Min<sup>a,e,1</sup> 



# Micro-/nanoplastics

Exposure levels

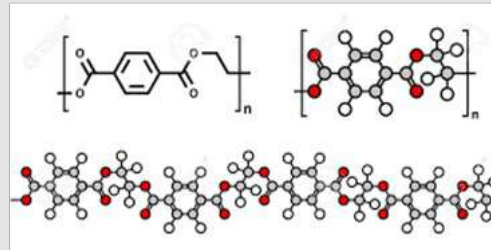
Bioaccumulation potential



Particle toxicity

Chemical effects

Microbial effects



# Challenges of MNP-research

- How to detect and test MNP (in samples/complex matrices)?
  - Physicochemical analytics
  - Particle-dependent dosing (in cell-culture systems)
- What characteristics of MNP are relevant for exposure/hazard?
  - Shape, Size, Surface chemistry
  - Chemistry---contents/corona (biofilm)---leachates
- **Virgin/pristine vs Aged/weathered MNPs**
- **Primary vs secondary MNPs**

# Summing up and conclusions

- Micro- and nanoplastics (MNPs) are a huge and complex challenge for hazard, exposure and risk assessment.
- Virgin/pristine MNPs seem not very effective on the immune system. Weathering/aging (altered surface chemistry, leachates, microbial substances) render MNPs immunoactive.
- Currently, we cannot assess the human health risk, because appropriate data and knowledge are lacking. Nevertheless for MNPs it is important to consider the precautionary principle



# Thank you for your attention.



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