SUCCESS STORY

microONE
Microplastic Particles: A Hazard for Human Health

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Module

Type of project: Labeling–Evaluation–Model Systems,01/2022-12/2025; multi-firm

MICRO- AND NANOPLASTICS BREACH THE BLOOD-BRAIN BARRIER (BBB)

ORALLY ADMINISTERED MICRO- AND NANOPLASTIC PARTICLES CAN REACH THE BRAIN ALREADY TWO HOURS AFTER EXPOSURE. DEPENDING ON ITS OUTER SHELL (CORONA), THESE SMALL PARTICLES ARE EVEN ABLE TO ENTER THE HIGHLY RESTRICTED BLOOD-BRAIN BARRIER, THUS POSING A POTENTIAL RISK TO SENSITIVE NEURONAL STRUCTURES.

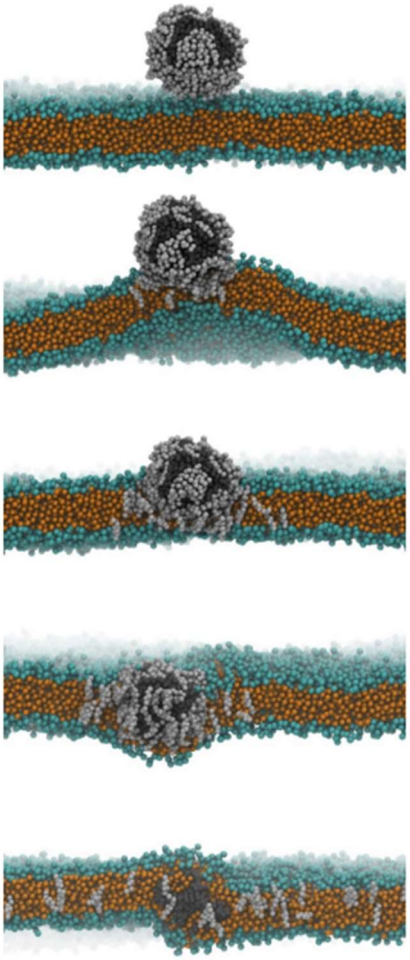
Micro-/nanoplastics (MNPs) are a growing concern, both for human health and the environment, due to their widespread distribution and potential harmfulness. Humans ingest a significant amount of MNPs through their diet, and plastic fragments are increasingly found in body fluids and tissues, such as blood and the placenta. Since 2022, the research partners around CBmed have been studying the effects of these particles on human health and are raising awareness about the associated risks.

MNPs have shown to enter the body, cross the intestinal mucosal barrier and are distributed across the body via the blood stream. The blood-brain barrier (BBB) is an even stronger barrier than the intestinal barrier and highly restricts particle and substance exchange as it protects the brain from external pathogens and toxins. How MNPs can breach various biological barriers (including the BBB), are taken up in the body and whether they can accumulate in various organs is one of the main goals in the FFG-funded project ***microONE.***

MNP corona influences uptake into the BBB

The mechanism of transport of MNPs through the intestinal barrier and cellular membranes is a complex process that depends on several factors such as particle size, charge, surface chemistry and the type of cell with which they interact. Together with our

project partner Oldamur Hollóczki the uptake of polystyrene nanoplastics across the BBB was simulated in computer models. Using different surface structures (biomolecular corona) on the nanoplastic particles, we could show that exactly this structure is crucial in enabling plastic particles to pass into the brain. While pristine polystyrene nanoparticles are even repelled by the BBB, a corona made of cholesterol – a lipid molecule often found in the blood stream and chemically similar to plastic - facilitates rapid uptake.

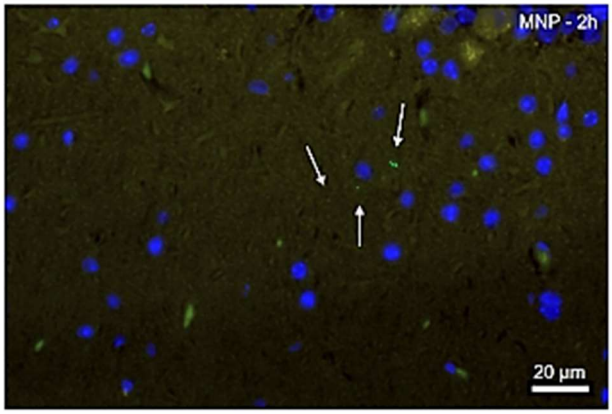


The image shows snapshots of a computer simulation how a cholesterol (light grey) covered polystyrene nanoparticles (dark grey) is drawn into the BBB (green: hydrophilic groups; orange: hydrophobic groups of the lipid bilayer).

Figure from: Kopatz et al., Micro- and Nanoplastics Breach the Blood–Brain Barrier (BBB): Biomolecular Corona's Role Revealed. Nanomaterials 2023

Micro- and nanoplastic rapidly observed in the brain

The results from the computer simulations were synergistically verified by the team of Lukas Kenner (CBmed and Medical University of Vienna) and Verena Pichler (CBmed and University of Vienna) using an in vivo animal model. Fluorescently labelled MNP-PS particles were detected in the brain of mice already 2 hours after a single dose administration. This highlights the rapid uptake and translocation of MNPs into the body and even across highly restricted barriers like the BBB.



The image shows a microscopy image of an immunofluorescent tissue section from a mouse brain at 2 hours after MNP administration. Arrows point at fluorescent nanoplastic particles.

Figure from: Kopatz et al., Micro- and Nanoplastics Breach the Blood–Brain Barrier (BBB): Biomolecular Corona's Role Revealed. Nanomaterials 2023

Impact and effects

These striking new data on the translocation of MNPs even across the BBB, which were acquired within scope of the microONE project, were published in the journal "Nanomaterials". The article raised high public awareness on the topic of MNPs in the brain both in the scientific and even in the non-scientific community. Further questions on the neurotoxicologic effects of MNPs in the brain and whether there particles are able to accumulate in the brain (and/or other organs) still has to be elucidated and is a task for our future research.

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This success story was provided by the CBmed GmbH and by the mentioned project partners for the purpose of being published on the FFG website. microONE is a COMET-Modul within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, SFG (Styria) and WAW (Vienna). The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet