A computational study of the interaction between nanoplastic and model biological membranes

Result in Brief

Effect of plastic particles on cell membranes

EU scientists investigated how tiny fragments of plastic impact biological membranes.

Each year millions of tonnes of waste plastic pollute the natural environment, which breaks down into micro and nanoscale particles before entering the food chain. It is well known that these plastic particles can transport toxic substances but their impact on living organisms is not yet clearly understood.

When plastic nanoparticles enter living organisms, the first barrier they face is the cell membrane. The EU-funded project NANOPLAST (A computational study of the interaction between nanoplastic and model biological membranes) investigated possible physical mechanisms behind damage to the cell membrane through interaction with plastic fragments.

Researchers developed new computational tools to simulate the interaction between nano-sized particles of common polymers and lipid membranes. They included new molecular coarse-grained models for the
two common hydrophobic polymers, polypropylene (PP) and polyethylene (PE).

The models were used to study the interaction of polymer nanoparticles with a homogenous membrane comprising a single type of lipid molecule and a laterally heterogeneous membrane made of a mixture of different lipids. The latter provided the most realistic model of plasma membranes, whose lipid composition is extremely rich.

NANOPLAST also fully characterised the behaviour of three hydrophobic polymers in model lipid bilayers: polyethylene (PE), polypropylene (PP) and polystyrene (PS). The different polymers' behaviour was not the same when interacting with homogenous membranes. For example, PP and PS dissolved in the core of the bilayer, while PE formed liquid aggregates. The behaviour of the three polymers also differed within heterogeneous membranes.

Changes to the membrane structure and lipid lateral organisation may pose a threat to the function of membrane proteins and other constituents, thereby altering the overall functioning of the cell. Hence, characterising the interaction of plastic particles with cell membranes will help scientists to better understand the chemical basis of their toxicity in all living organisms.

Plastics are now ubiquitous in the Earth's environment. NANOPLAST outcomes are a warning of their impact across the globe, highlighting the need to understand and reduce plastic waste efficiently.

**Keywords**

Cell membrane, nanoparticles, NANOPLAST, hydrophobic polymer, lipid

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