Nanoplastics: Wreaking Havoc in the Body

AUCHE 341
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Nanoplastics: What are they?

Nanoplastics (NP's) are small pieces of plastic, ranging from 1 nm to 1000 nm in size. There is two types, Primary and Secondary Derivatives. [1,2]

Primary Nanoplastics
- Nanoplastic waste disposed of into the environment

Secondary Derivatives
- Created from plastic degradation
- Plastic product → microplastics → nanoplastics

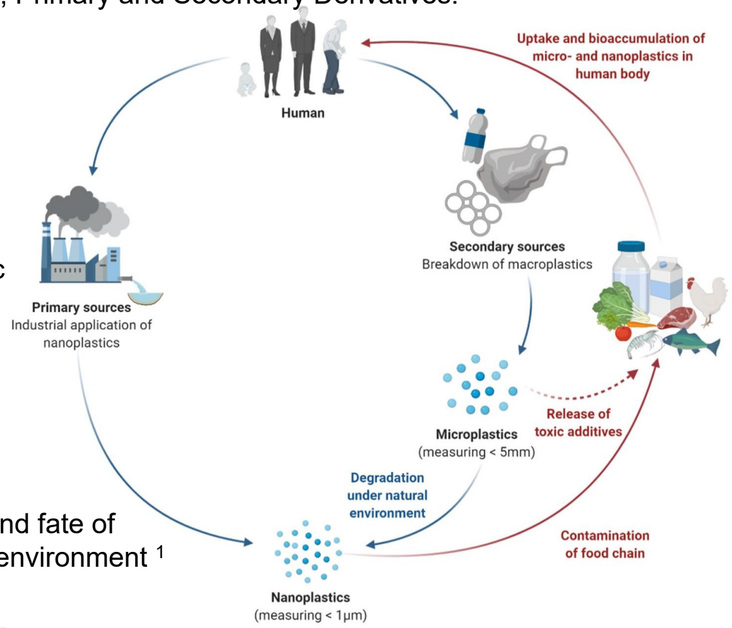
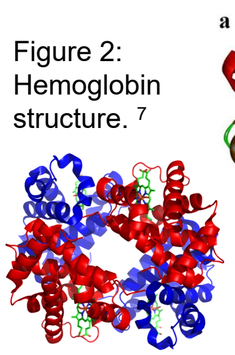


Figure 1: Sources and fate of nanoplastics in the environment [1]

Nanoplastic Interaction with Hemoglobin

The ability of being able to interact at a subcellular or molecular level to allows nanoplastics to interact with hemoglobin, the protein in red blood cells. The binding of polystyrene (PS) nanoplastics changes the hemoglobin from the relaxed state to the tensed state, which has a lower affinity for oxygen. Further research is needed to determine the consequences.[6]

Figure 2: Hemoglobin structure. [7]



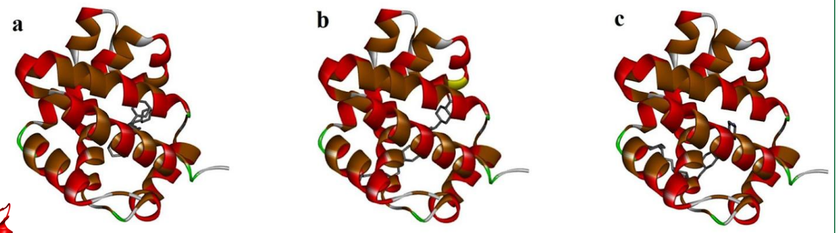


Figure 3: NP's interaction with B-chain of hemoglobin. a) PS. b) PS-COOH. c) PS-NH2. Brown represents hydrophobic residues interaction. Green represents hydrogen bonding. Yellow represents Van der Waal's interaction. [6]

Effects on Climate Change

Effects of nanoplastics on climate change and the environment include: [3]
- Emission of greenhouse gases
- Ecological disruptions
- CO_2 capacity of phytoplankton
- Development of clouds
- Reflectivity of water surfaces

Effects on Animals

Effects of nanoplastics on animals include: [2,3]
- Decreased growth rate
- Decreased reproductivity
- Decreased life expectancy
- Low nutrient absorption
- Inflammation
- Hormone disruption
- Oxidative stress

What Can We Do?

The best way to reduce micro and nanoplastics in the environment is to reduce plastic waste and increase recycling. [1]
Recent research shows limestone-quartz sand to be an effective filter when removing polystyrene nanoplastics from water. [8]

Material types	NP type	Amount (g)	Removal efficiency (%)
Quartz sand	PS	-	5.95
Manganese sand-quartz sand	PS-NH2	35 70	3.47 11.01
Zeolite-quartz sand	PS-NH2	70	1.95
Limestone-quartz sand	PS PS-COOH PS-NH2	70 70 70	93.33 92.94 92.92

Table 1: Removal efficiency of nanoplastics under various conditions.[8]

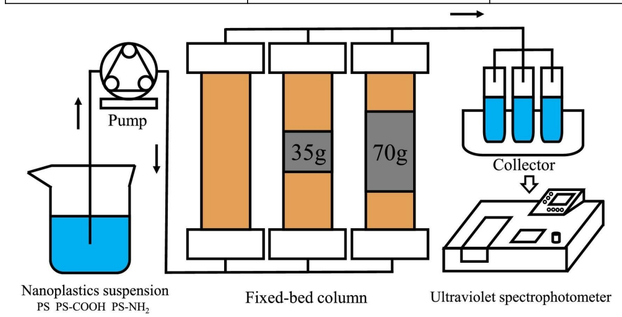


Figure 4: Diagram of the filtration column experiments. [8]

Effects on Humans

The effects of nanoplastics on humans needs further research. The potential effects are similar to the effects in animals.

There is a potential link between nanoplastics and the development of Parkinson's or other dementia related diseases.[4]

Nanoplastics can act as a transport for toxic substances to enter the body, which have their own effects on the body.
An example is heavy metals (Pb^{2+} and Cd^{2+}) being transported by polystyrenes. The heavy metals can cause neurological damage, organ dysfunction and risk of chronic diseases. [3]

Nanoplastics enter the body by inhalation, dermal exposure or oral consumption. Once inside the body they can cross biological membranes and enter circulatory systems and interact at the subcellular or molecular level. [1,5]

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