Human health effects of micro- and nano- plastics

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Current state of knowledge

• Currently *no published data* to indicate that marine micro- and nano-plastics pose a risk to human health

• Much evidence for the *plausibility* that such a risk exists
Plastics attract contaminants

- Microplastics rapidly sorb organic material, metals, bacteria and persistent, bioaccumulating, toxic substances

Leaching of additives

<table>
<thead>
<tr>
<th>Polymer type</th>
<th>Hazard ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>1</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>11</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>1,628 – 1,630</td>
</tr>
<tr>
<td>polyamide</td>
<td>63 - 50</td>
</tr>
<tr>
<td>Polyethylene teraphthalate</td>
<td>4</td>
</tr>
<tr>
<td>polyvinylchloride</td>
<td>10,5001 – 10,551</td>
</tr>
</tbody>
</table>

Polymers identified in marine debris, relative hazard derived from constituent monomers and additives, from Lithner et al 2011 and Galloway 2015
Ingestion

• Uptake across gut: via microfold (M) cells, optimum size < 200nm

Particles accumulate in liver and gall bladder before excretion via faeces and urine

Galloway 2015 in Marine Anthropogenic Litter

Inhalation

• Inhaled fibres induce inflammation, esp. >20 μm high aspect ratio persistent fibres

• Further uptake requires avoidance of mucociliary clearance

Pauly 1998  Cancer Epidemiol Biom prev
Dermal uptake

- Uptake of particles across skin requires penetration of striatum corneum, limited to <100nm

Sykes et al 2014 Nature Commun 5: 3796
Exposure through seafood?

- mean $0.36 \pm 0.07$ particles g$^{-1}$ mussel, $0.47 \pm 0.16$ g$^{-1}$ oyster

- European shellfish consumer could ingest 50 particles per plateful, 11,000 particles per year

Van Cauwenberghe and Janssen, 2014 Env Poll 193:65-70
Atmospheric fallout

- 29-280 particles / m³ / day on urban rooftops in Paris
- Mostly fibres, optimum size 200-600 μm

Dris et al 2015 Environ Chem
‘the internal dose is at the heart of the relationship between exposure and health effects’..(Needham et al., 2007)
### National Health and Nutrition Examination Survey NHANES

**Chemicals measured in 3000+ respondents**

<table>
<thead>
<tr>
<th>Chemical Category</th>
<th>2001/2</th>
<th>2003/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioxins, Furans, and Coplanar PCBS</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>Non-Dioxin-Like Polychlorinated Biphenyls (PCBs)</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Urinary Polycyclic Aromatic Hydrocarbons (PAHs)</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Volatile Organic Compounds</td>
<td>20</td>
<td>38</td>
</tr>
<tr>
<td>Organochlorine Pesticides</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Urinary Phthalates</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Urinary Heavy Metals</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Urinary Organophosphate Insecticides</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>Urinary Perchlorate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Environmental Phenols</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Polyfluorinated compounds</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Urinary Total Arsenic and Speciated Arsenics</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Polybrominated diphenyl ethers</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>176</td>
<td>201</td>
</tr>
</tbody>
</table>
Research questions

• How prevalent is seafood contamination with microplastics?
• Do microplastics constitute a significant source of persistent, bioaccumulating and toxic contaminants of pathogens to humans?
• How does this compare with direct exposure to seafood? To water?
• What methods can be used to identify and characterise microplastics in human tissues?
Novel methods

- Novel techniques for studying human biopsy samples.

Raman Imaging using Renishaw Streamline

Peak Height Map

Control Beads

Beads in Tissue
Coherent anti-stokes Raman spectroscopy

Raman scattering image at 2845 cm$^{-1}$ (C-H bond resonance)

Polystyrene microsphere

Watts et al., 2014 ES&T
Thank you

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• Dr Andrew Watts, Exeter

CleanSea

www.cleansea-project.eu

NERC

www.defra.gsi.gov.uk

Wellcome Trust

plasticpollution.co.uk

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