Human health effects of micro- and nano- plastics

UNIVERSITY OF EXETER

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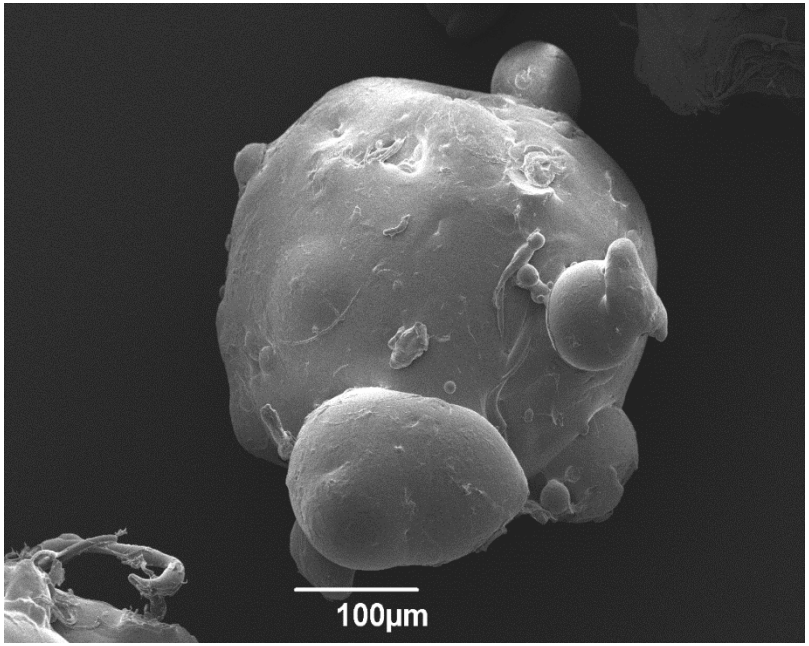
Current state of knowledge

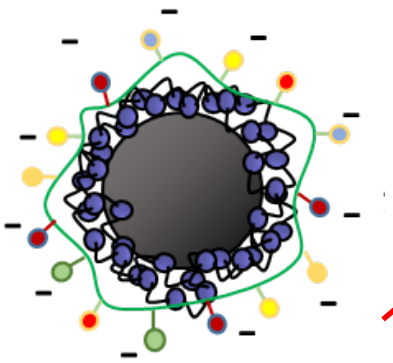
- Currently *no published data* to indicate that marine micro- and nano-plastics pose a risk to human health
- Much evidence for the *plausibility* that such a risk exists

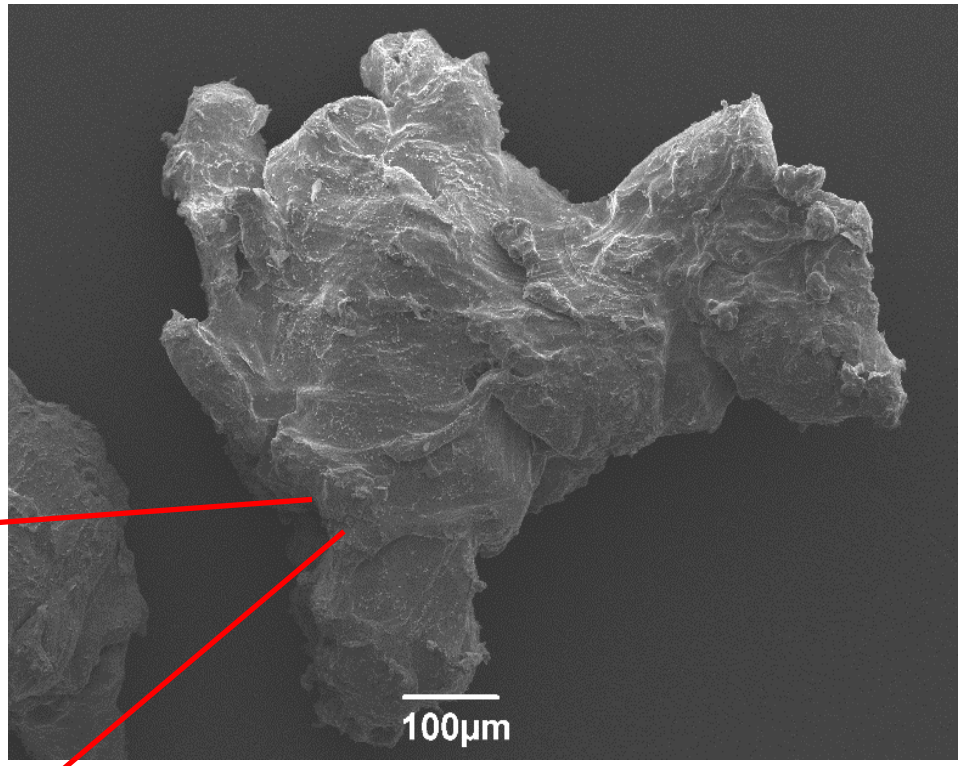


Polypropylene microbead from showergel, SEM image

Plastics attract contaminants

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

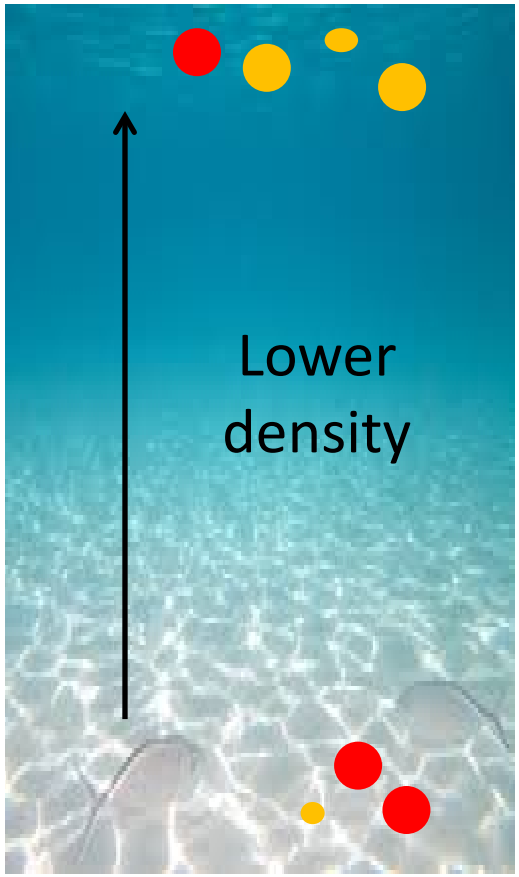




Ashton et al 2010, Holmes al 2012, Rochman et al 2014
Boucher et al 2015, Zettler et al 2013, Takada et al 2011, 2015

Leaching of additives

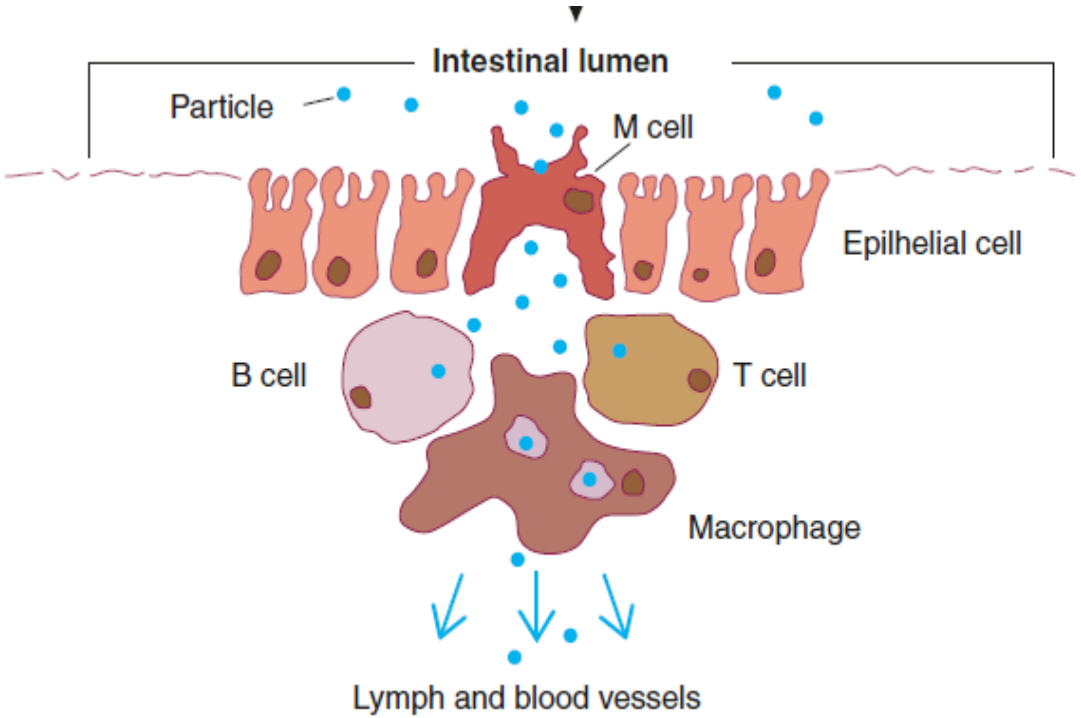
Polymer type	Hazard ranking
Polypropylene	1
Polyethylene	11
Polystyrene	1,628 – 1,630
polyamide	63 - 50
Polyethylene teraphthalate	4
polyvinylchloride	10,5001 – 10,551



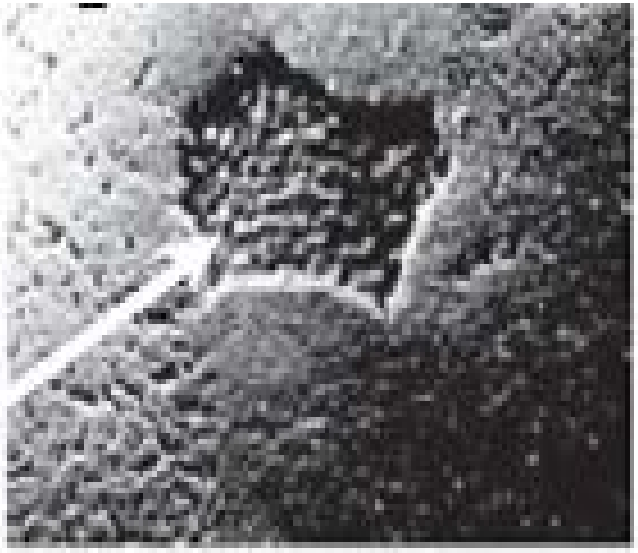
Polymers identified in marine debris , relative hazard derived from constituent monomers and additives, from Lithner et al 2011 and Galloway 2015

Ingestion

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



Galloway 2015 *in* Marine Anthropogenic Litter

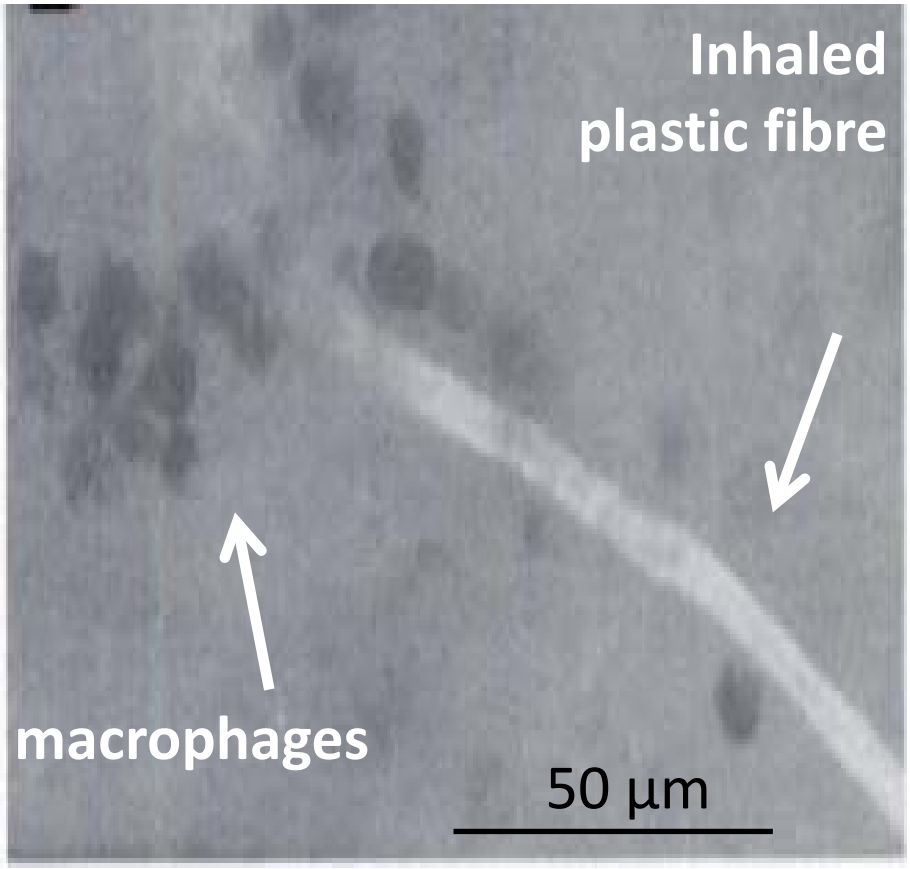


Mowat 2003 Nature. Rev Immunol

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

Inhalation

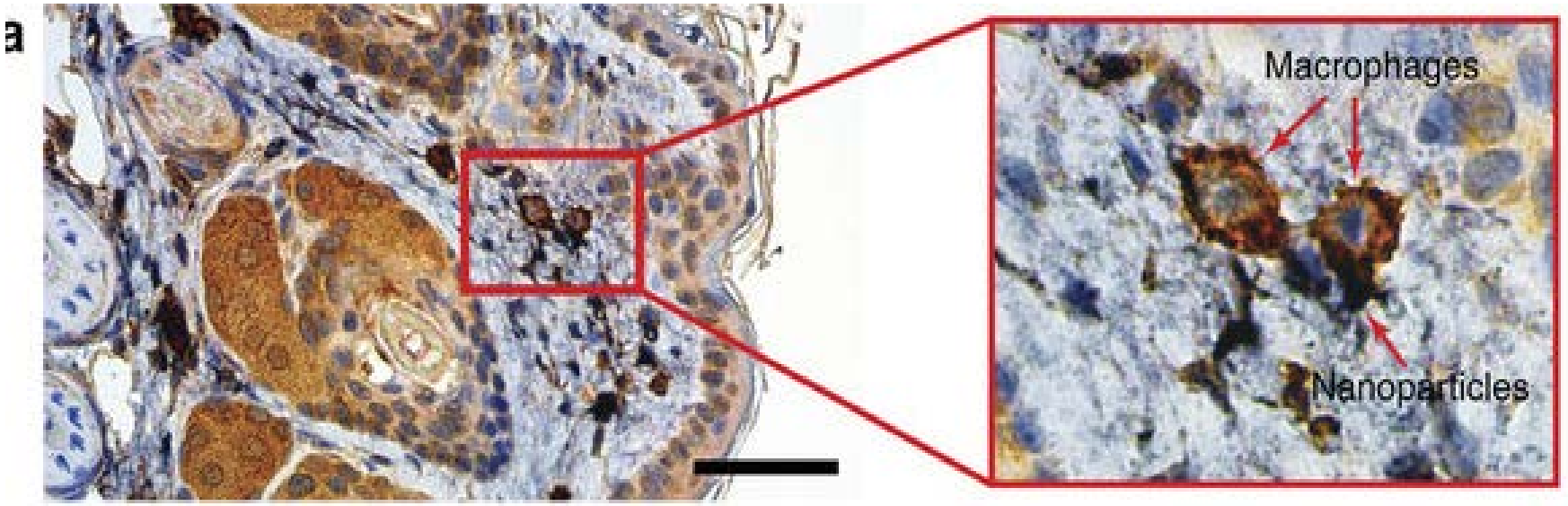
- Inhaled fibres induce inflammation, esp. >20 µm high aspect ratio persistent fibres
- Further uptake requires avoidance of mucociliary clearance



Pauly 1998 Cancer Epidemiol Biom prevent

Dermal uptake

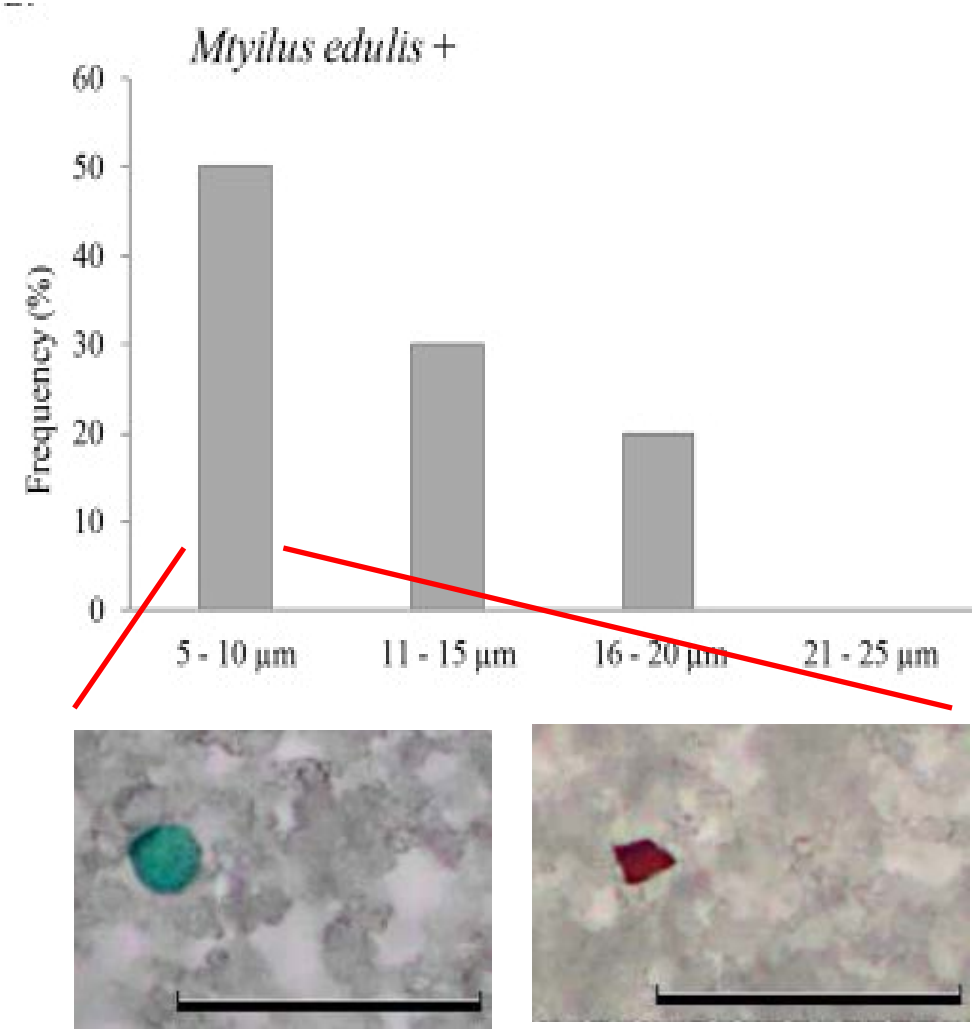
- Uptake of particles across skin requires penetration of striatum corneum, limited to <100nm



Sykes et al 2014 Nature Commun 5: 3796

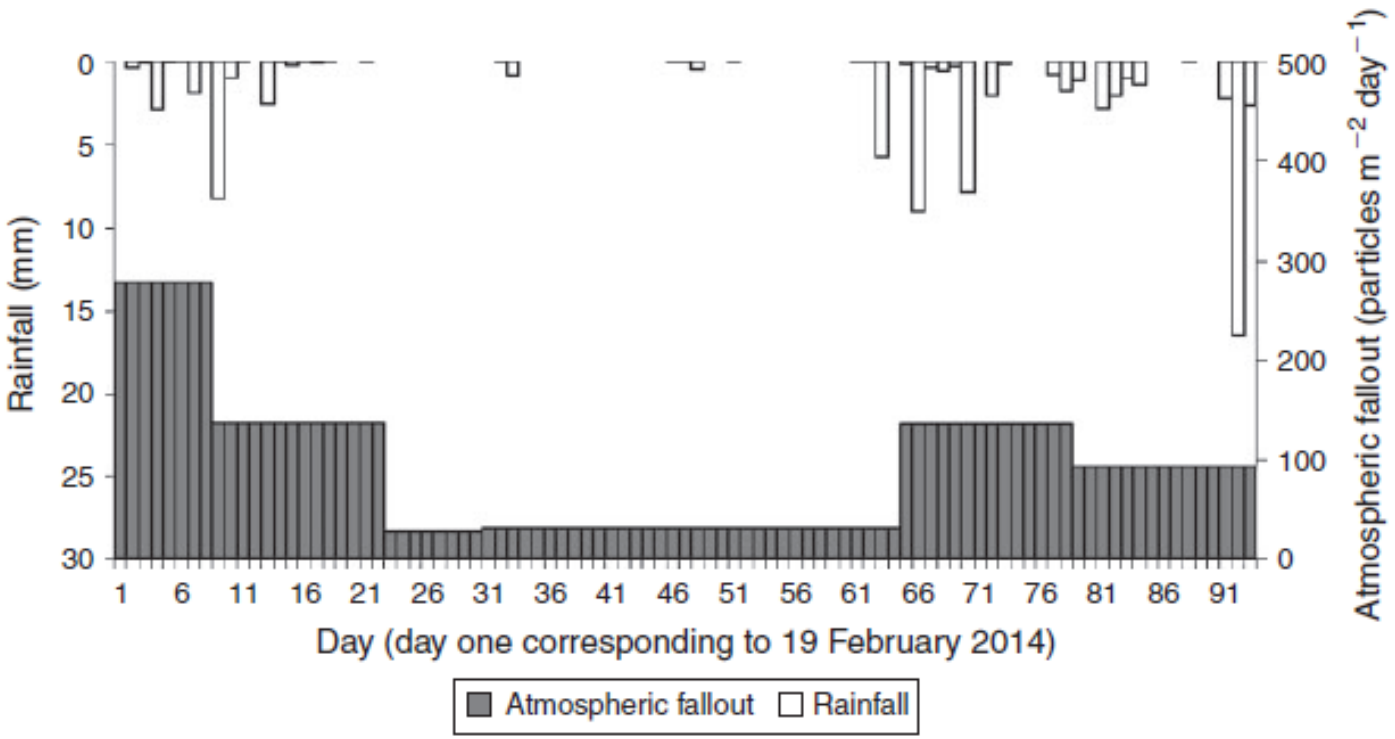
Exposure through seafood ?

- mean 0.36 ± 0.07 particles g^{-1} mussel, 0.47 ± 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 / m^3 / day on urban rooftops in Paris
- Mostly fibres, optimum size 200-600 µm

Dris et al 2015 Environ Chem

Human Biomonitoring

'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

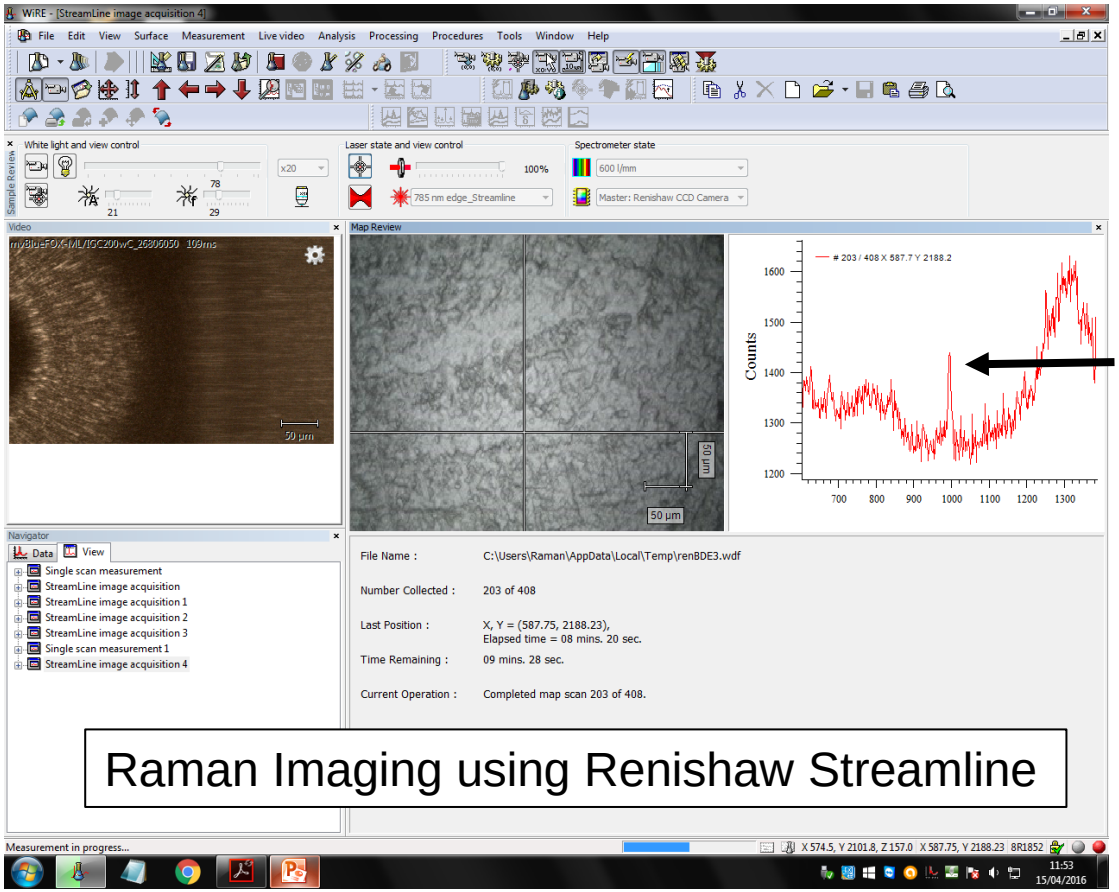
	2001/2	2003/4
Dioxins, Furans, and Coplanar PCBS	28	29
Non-Dioxin-Like Polychlorinated Biphenyls (PCBs)	23	26
Urinary Polycyclic Aromatic Hydrocarbons (PAHs)	21	21
Volatile Organic Compounds	20	38
Organochlorine Pesticides	13	13
Urinary Phthalates	19	13
Urinary Heavy Metals	12	12
Urinary Organophosphate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

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.

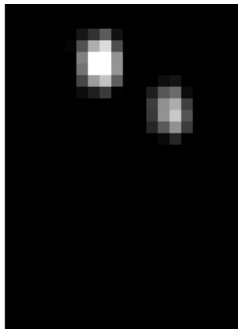


Raman Imaging using Renishaw Streamline

Bead Peak

Peak Height Map

Control Beads



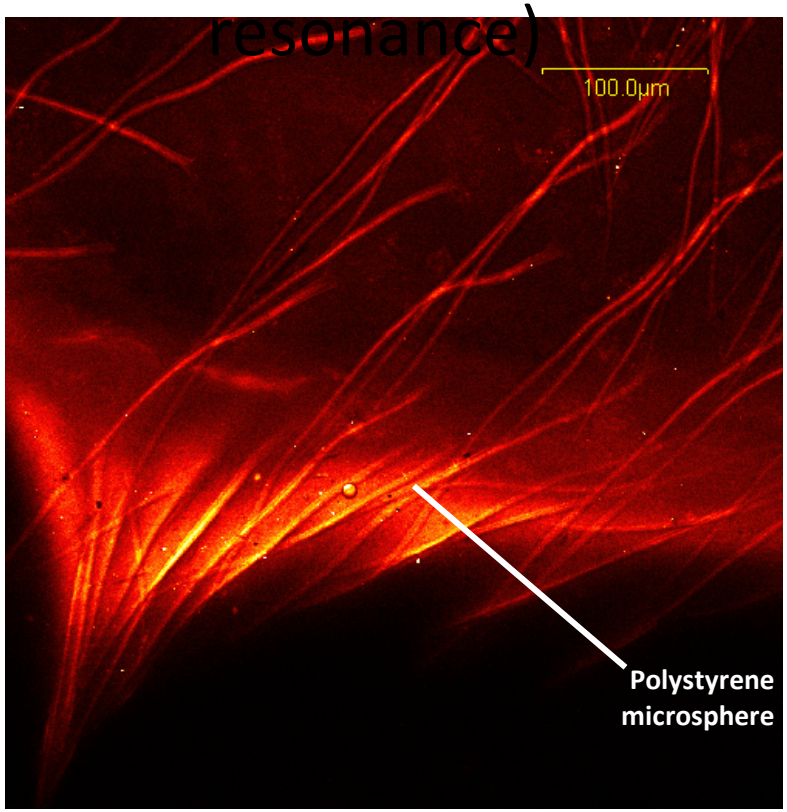
Beads in Tissue

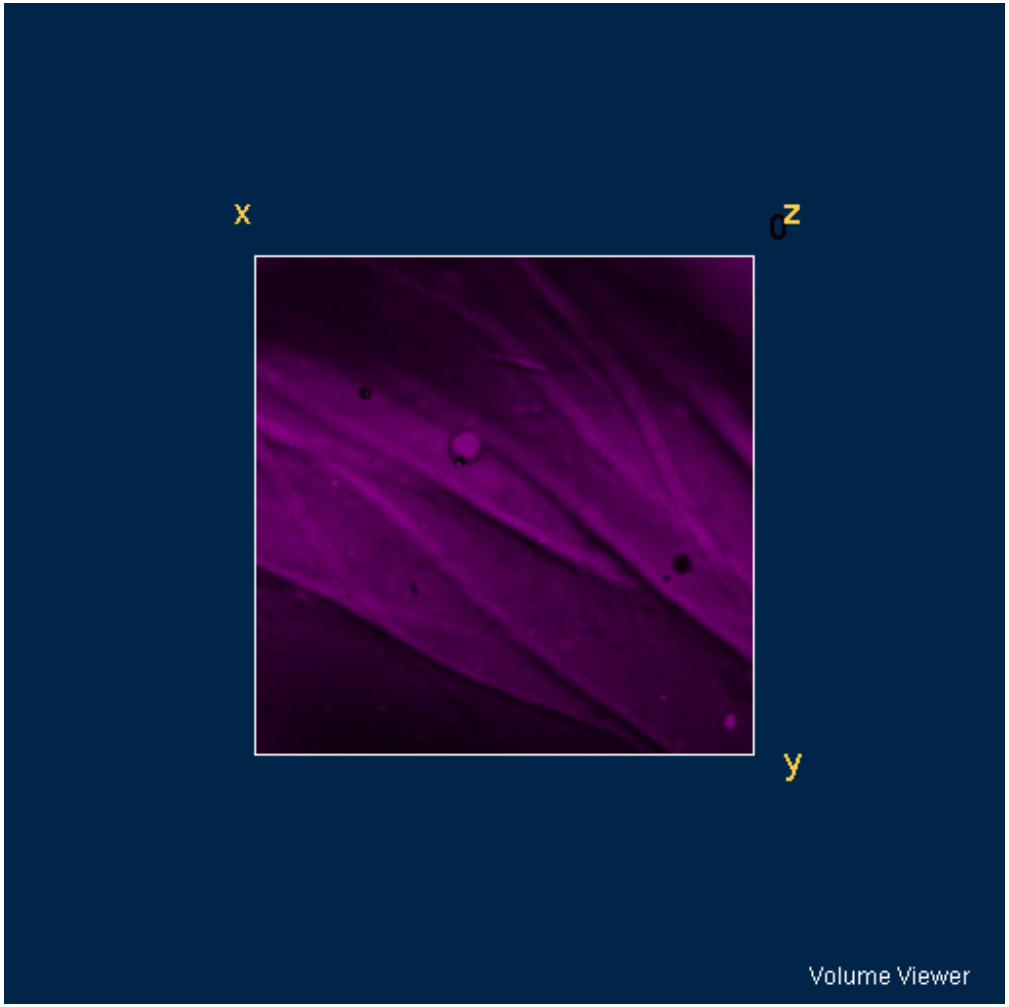
MRC-PHE
Centre for Environment & Health

MRC Medical Research Council | Public Health England | Imperial College London | King's College London

Coherent anti-stokes Raman spectroscopy

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





Watts et al., 2014 ES&T

Thank you

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CleanSea

www.cleansea-project.eu

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