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MIPs for imaging and therapeutic applications

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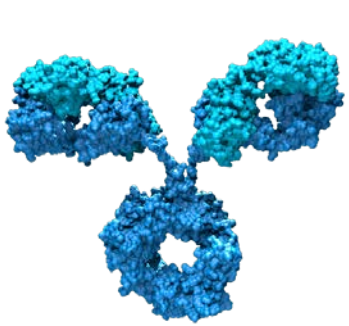
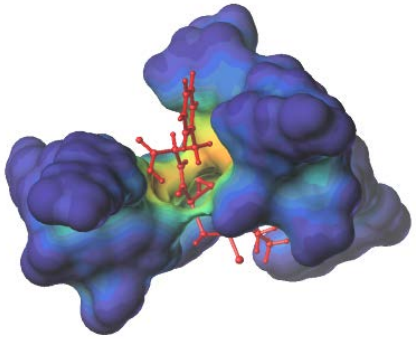
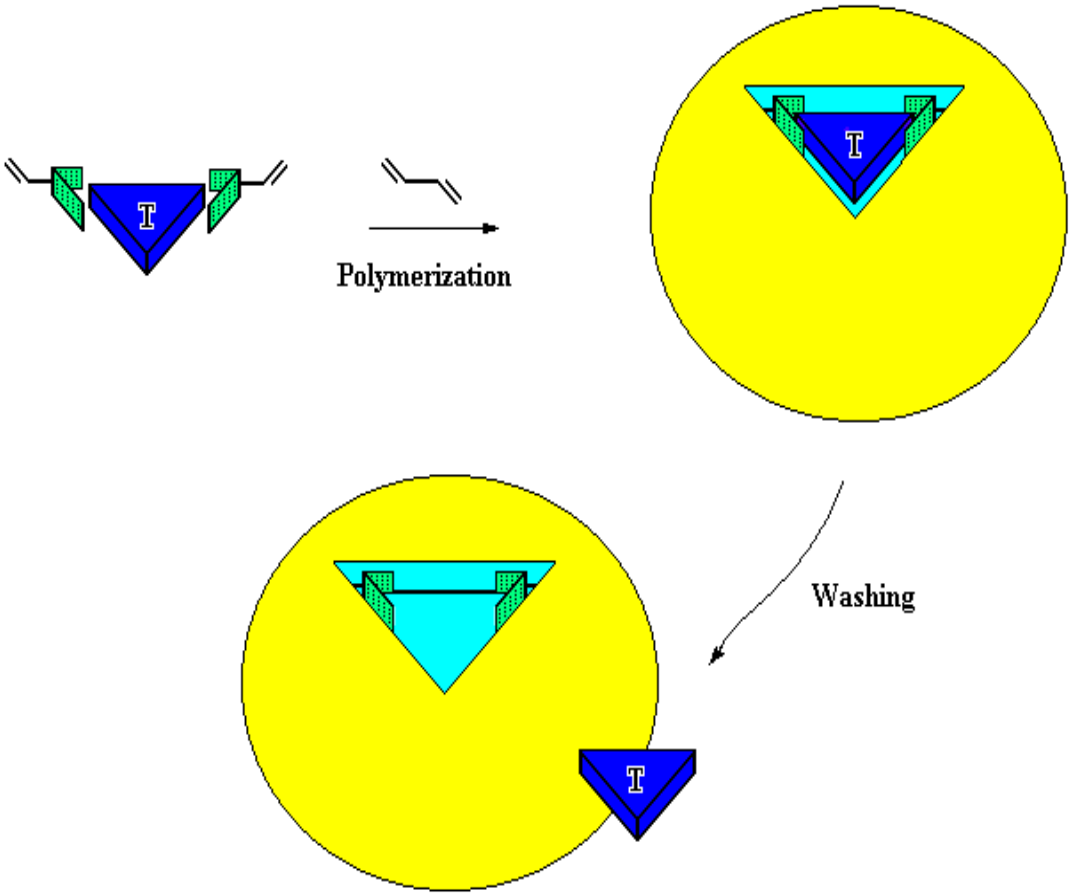
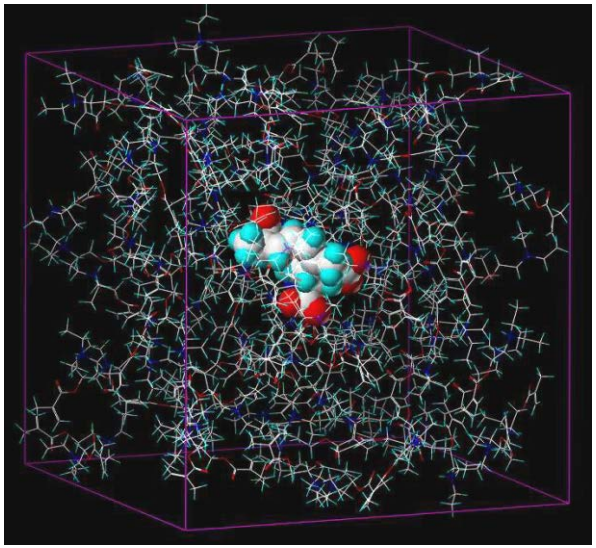




Molecular imprinting





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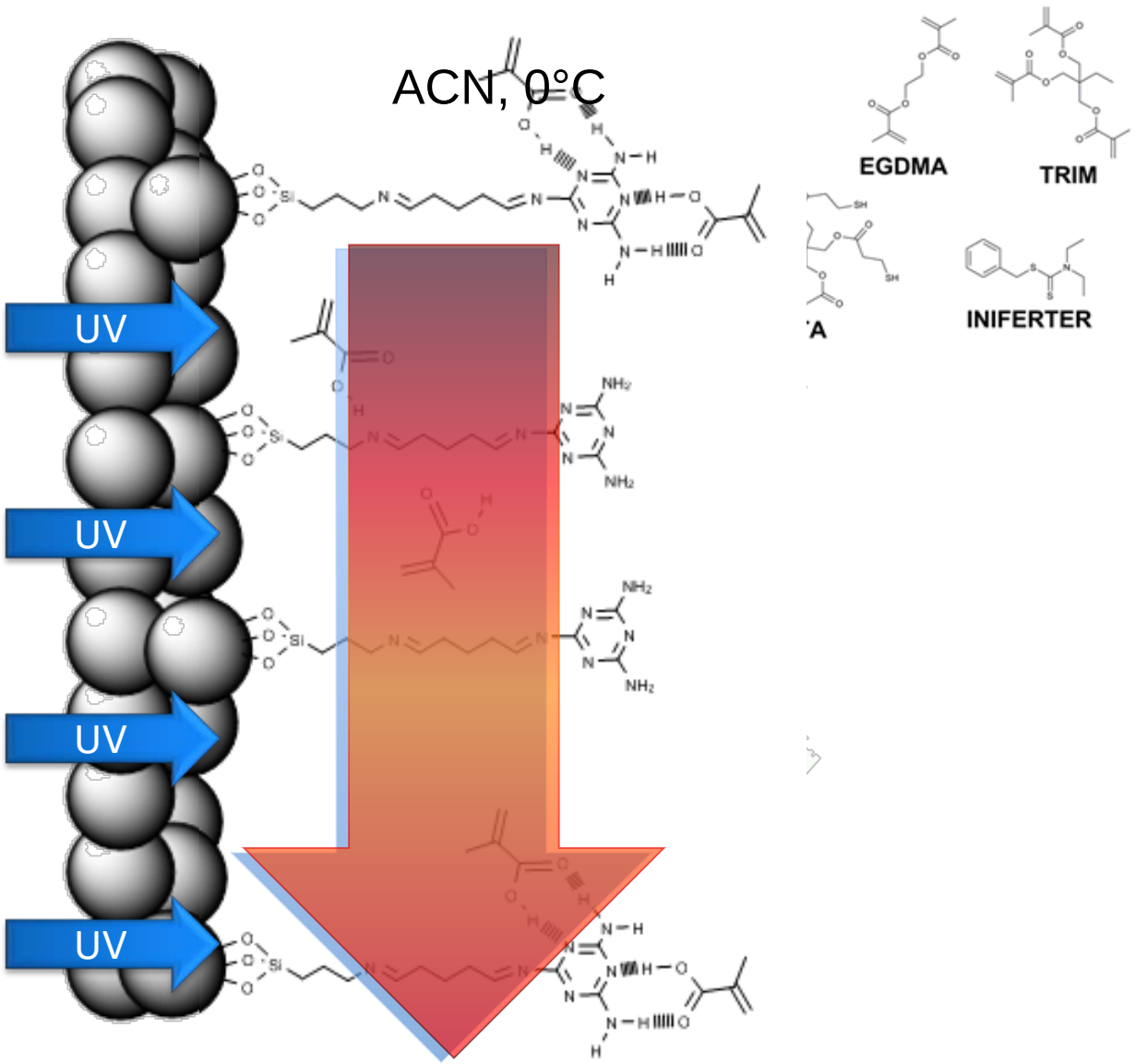
Solid-phase synthesis of nano-MIPs



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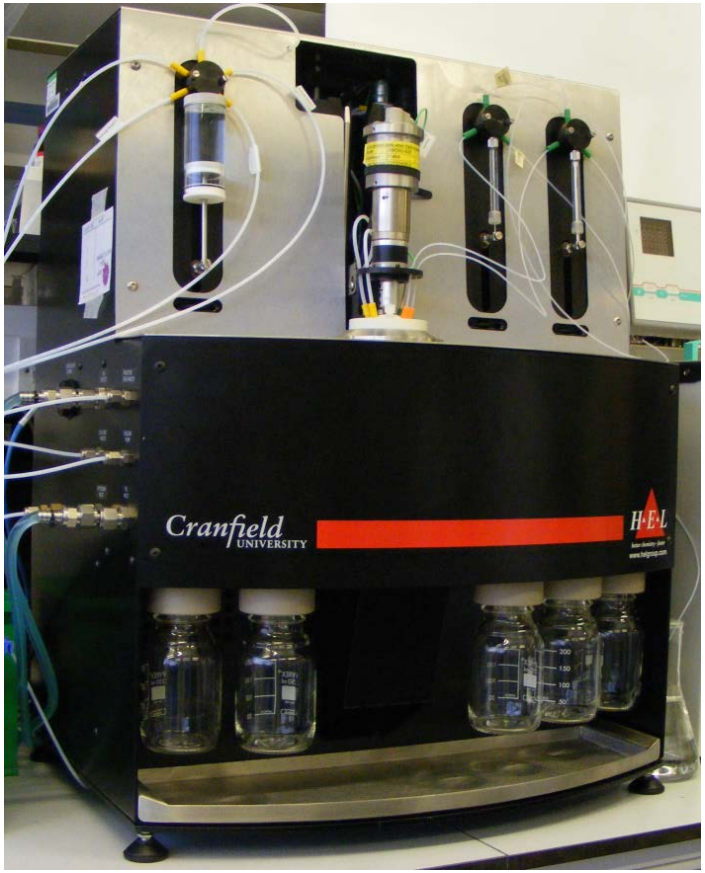
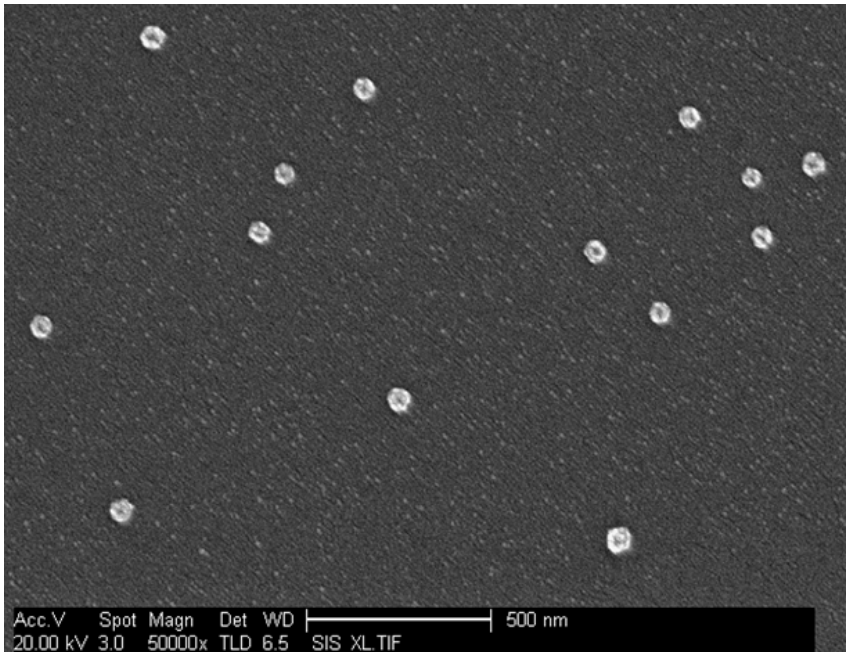
Synthesiser for MIP nanoparticles

Automatic reactor for MIP nanoparticles





- Manufacturing cycle – 3.5 hours
- Yield – 50 mg (can be scaled up)

(Piletsky S. A., Guerreiro A., Whitcombe M. J. Preparation of molecularly imprinted polymers. **UK 0921025.3, EP 2507278 A1**)

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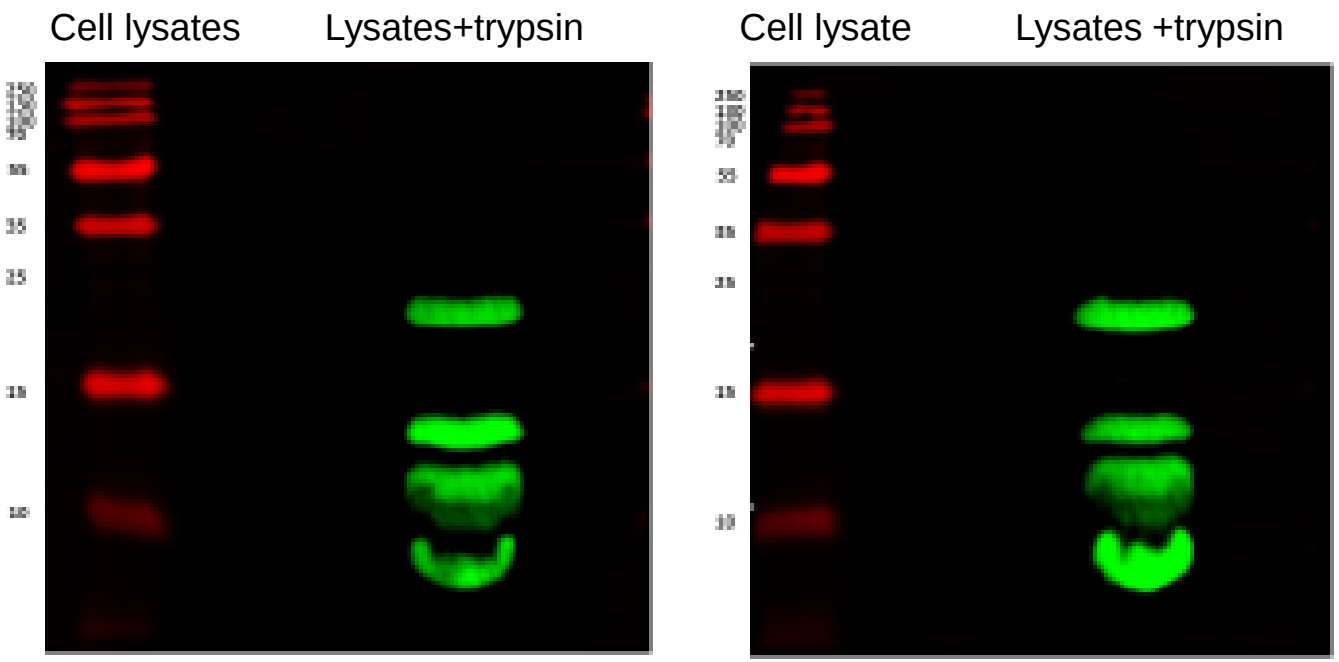
Western blots: Ab versus MIPs

Antibodies

MIPs



Samples were labelled with DyLight 800

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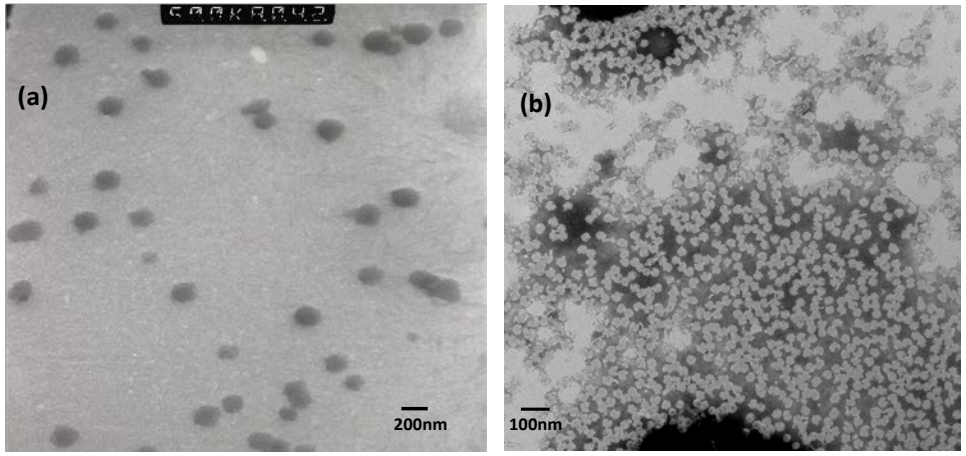
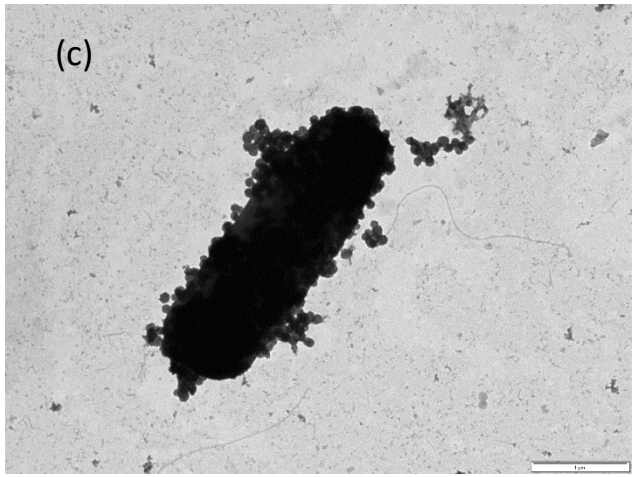
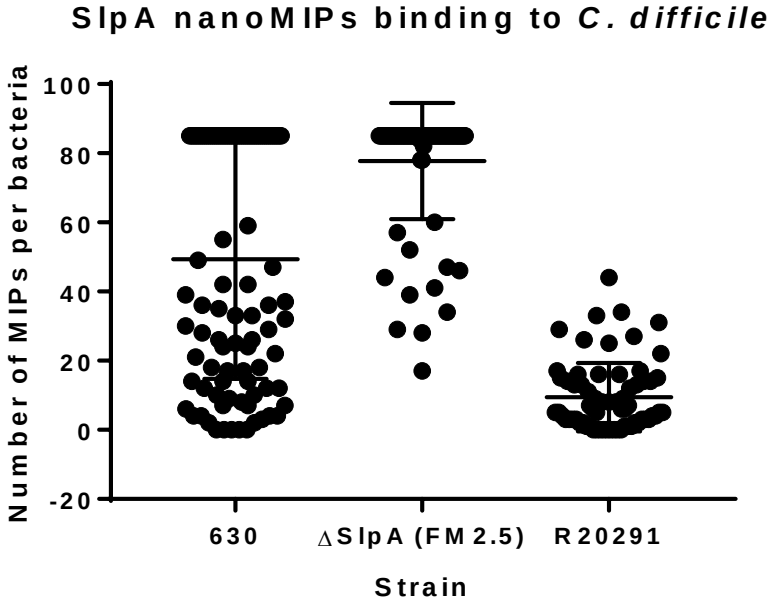
MIPs for viruses and bacteria



CureCN

TEM images of MIP-nanoparticles (a), bacteriophage MS2 (b), and C difficile with MIP nanoparticles (c).





(*Anal. Chem.*, **87**, 6801−6807, 2015; *Nature Protocols*, **11**, 443-455, 2016)

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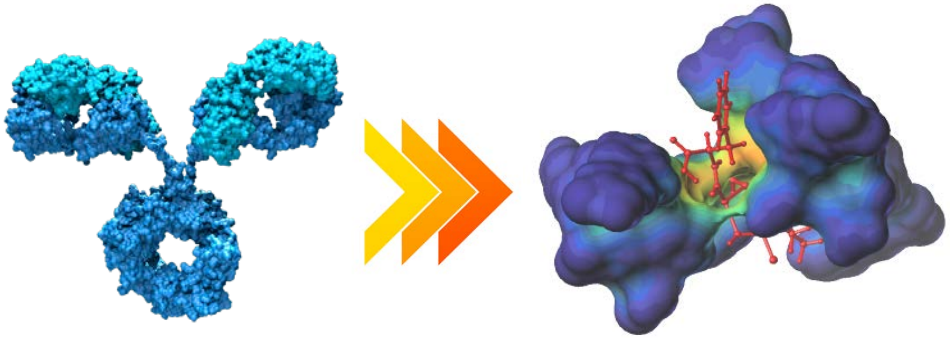
MIPs in assays



Comparison with antibodies

Template	MIP size, nm	Detecion limit for assay with MIP, nM	Detection limit in assay with antibodies, nM
Biotin	104±6	$1{,}20\times10^{-3}$	$2{,}54\times10^{-3}$
L-Thyroxine	164±11	$8{,}07\times10^{-3}$	17,5
Glucosamine	138±16	$4{,}01\times10^{-4}$	$3{,}38\times10^{-4}$
Fumonisin B2	94±4	$6{,}12\times10^{-3}$	$2{,}5\times10^{-2}$
Hemoglobin	149±15	$8{,}7\times10^{-2}$	$1{,}54\times10^{-4}$
Glycated hemoglobin ("polyclonal")	103±14	$2{,}46\times10^{-3}$	-
Glycated hemoglobin ("monoclonal")*	103±14	$9{,}49\times10^{-3}$	$2{,}38\times10^{-4}$

(*Sci. Reports*, **6**, 37638, 2016).

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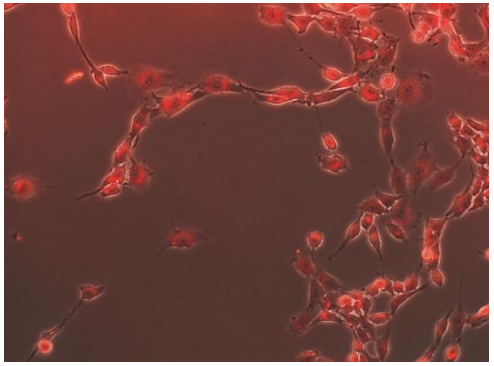
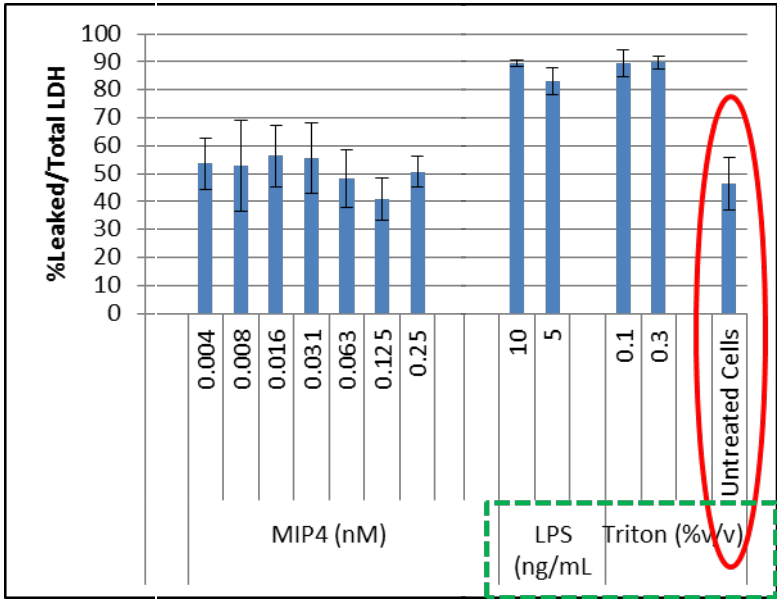
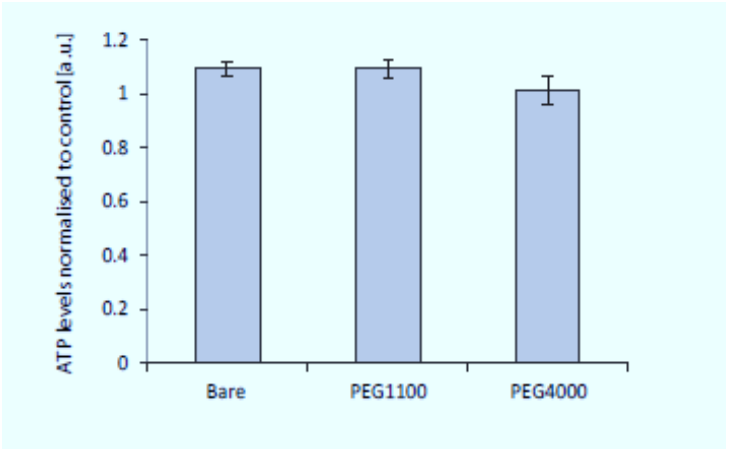
Theranostics and imaging

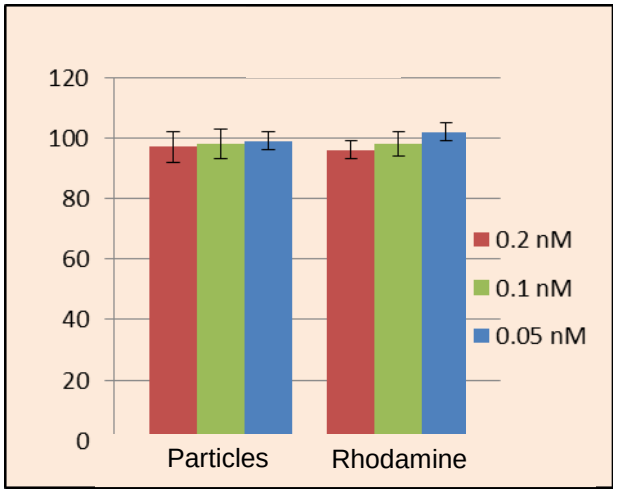




LDH assay (macrophages NR8383)



ATP assay



MTT test

Nano Research, **9**, 3463–3477, 2016.

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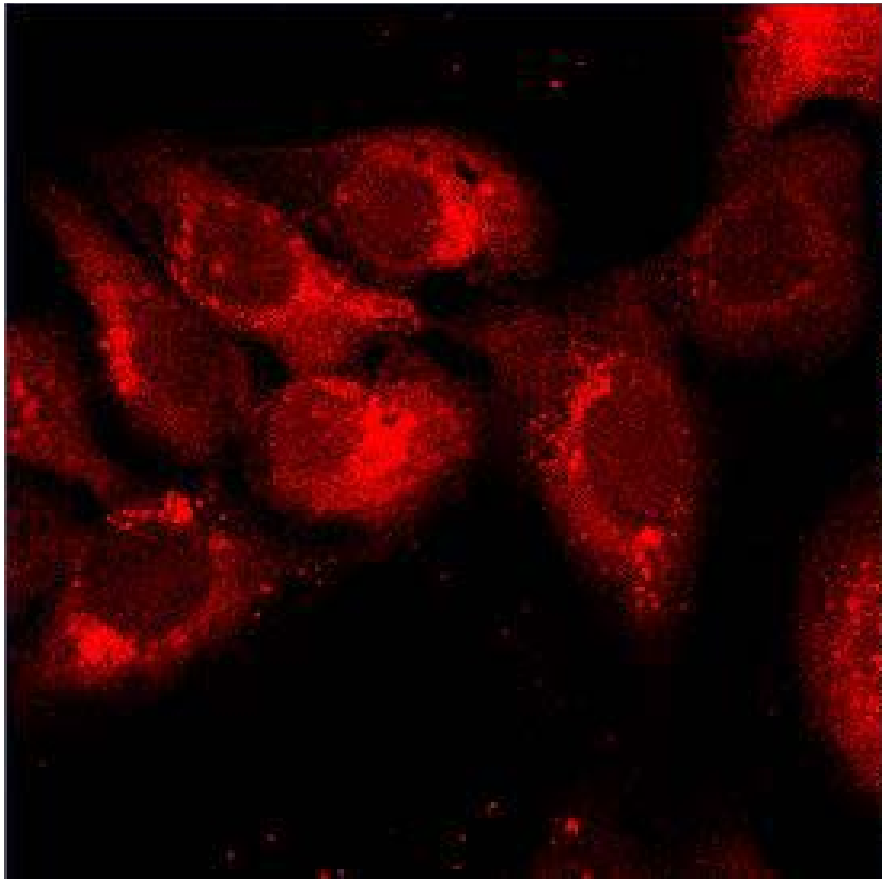
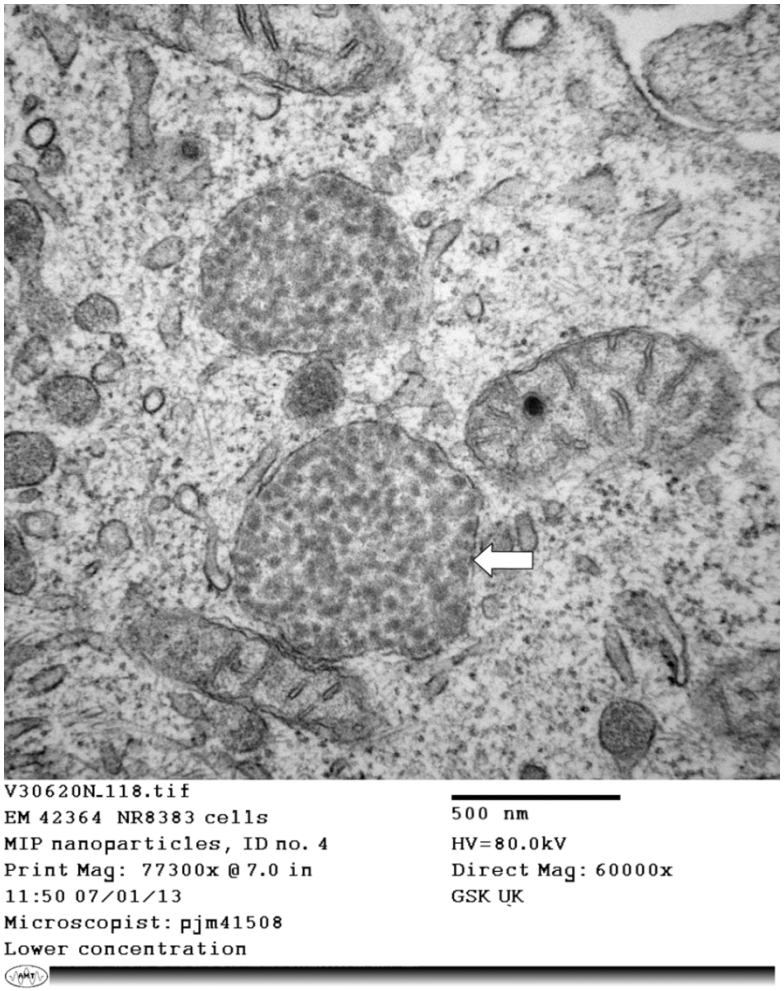
Cell membrane permeation





(*Nano Research*, **9**, 3463–3477, 2016).

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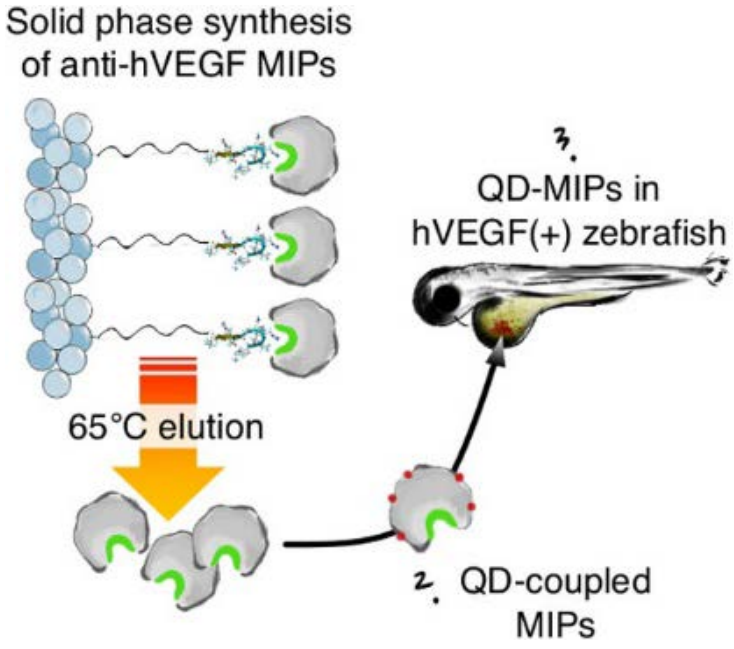
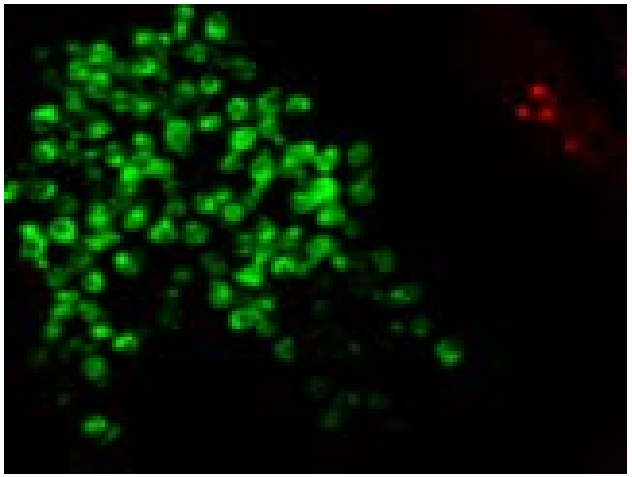
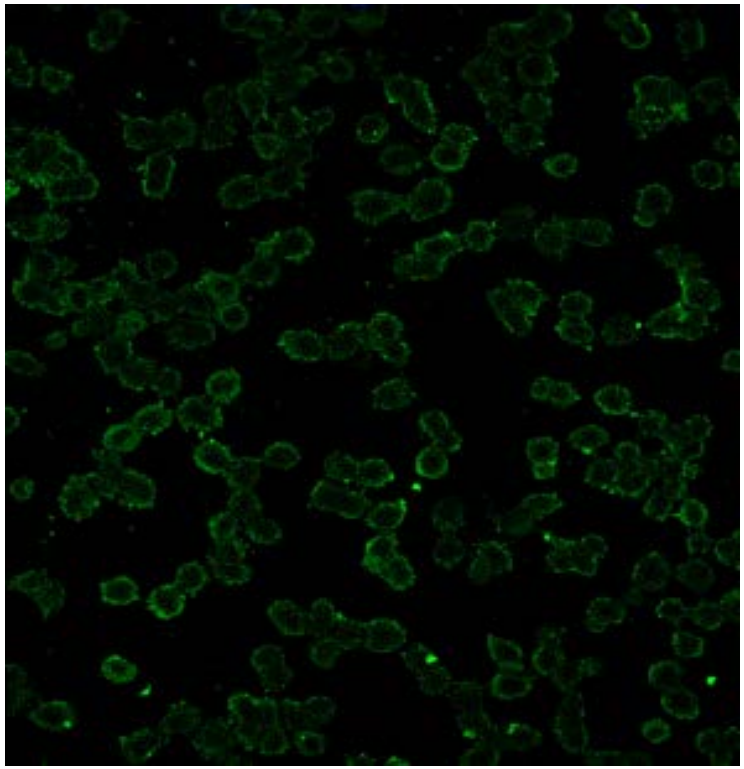
Imaging - targeting of cancer cells







MIP nanoparticles binding to EGFR

(*NanoLetters,* 17, 2307-2312, 2017; *NanoLetters,* in press, 2018)

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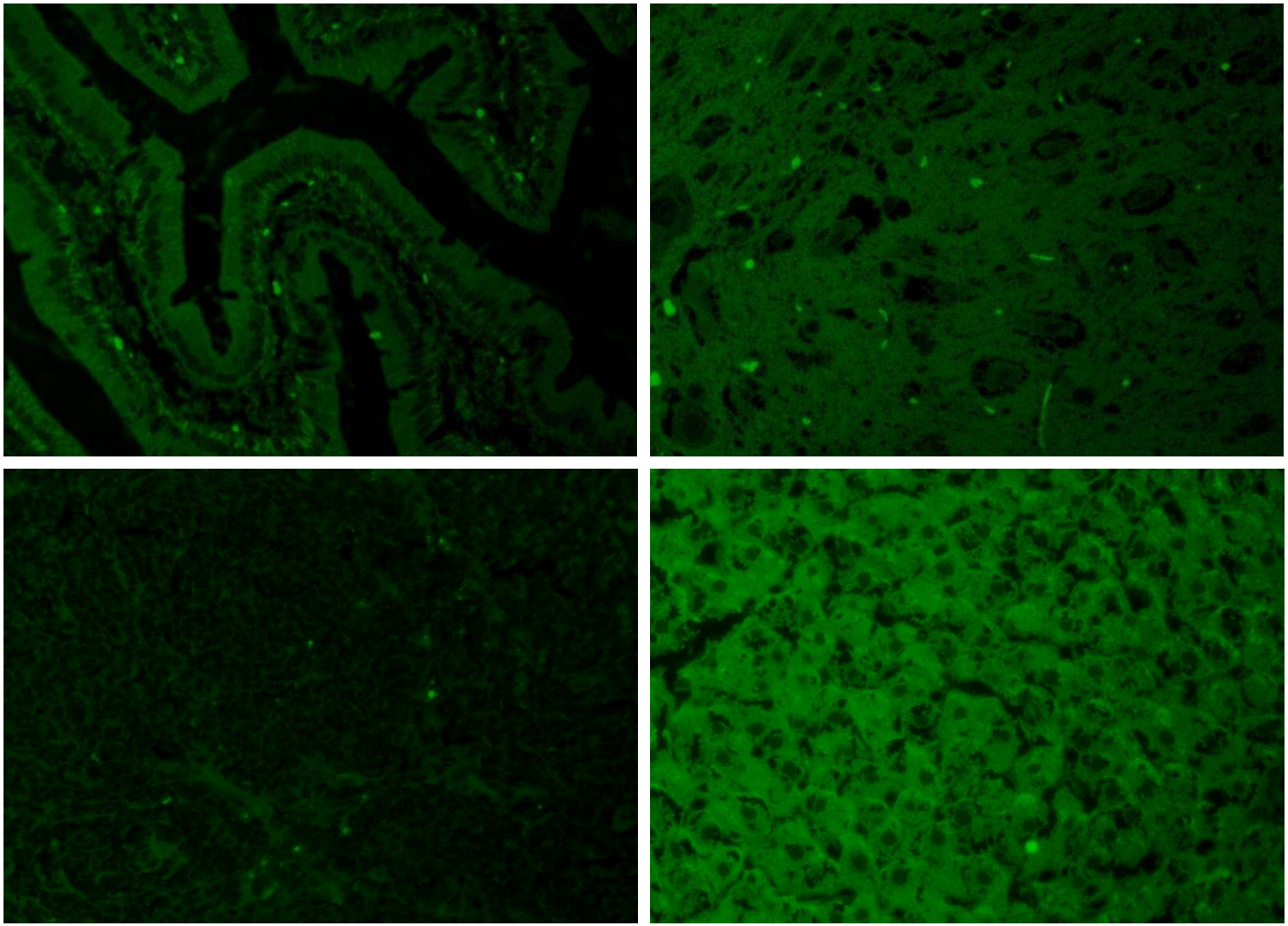
Oral delivery of nanoMIPs



a) Intestines
b) Spleen
c) Brain
d) Liver
72 hours after consumption

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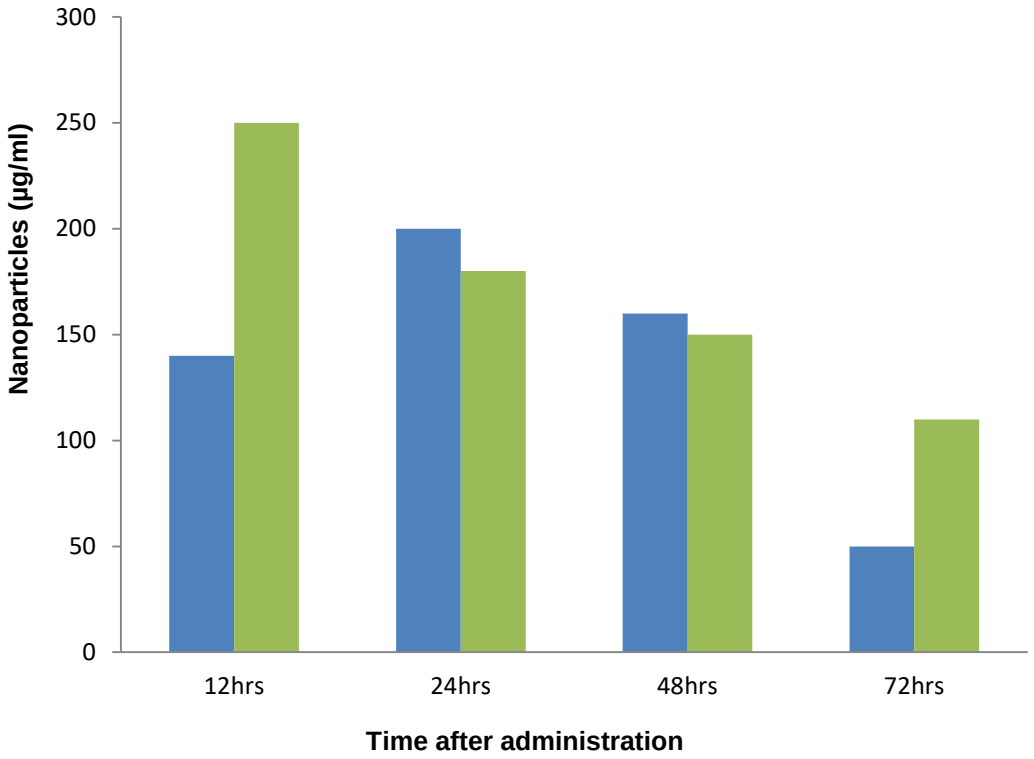
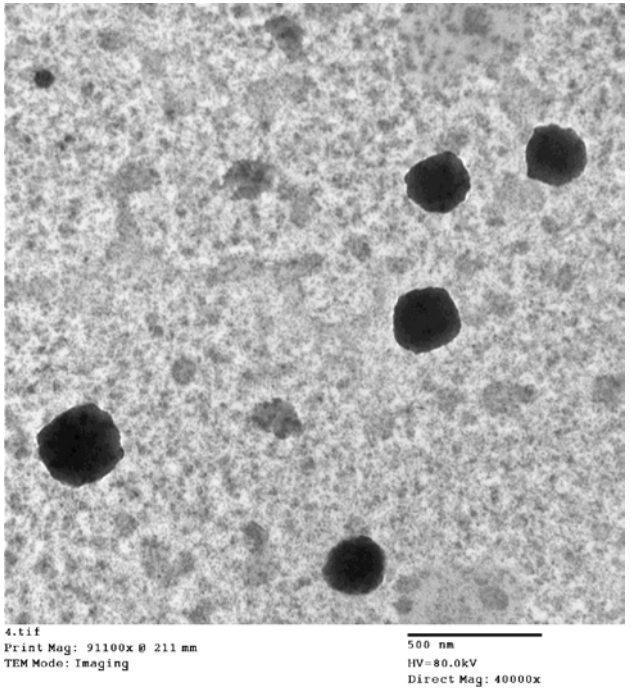
Clearance





Clearance of nanoMIPs with faeces delivered intravenously (blue) and orally (green) (no particles were detected after 1 week time)

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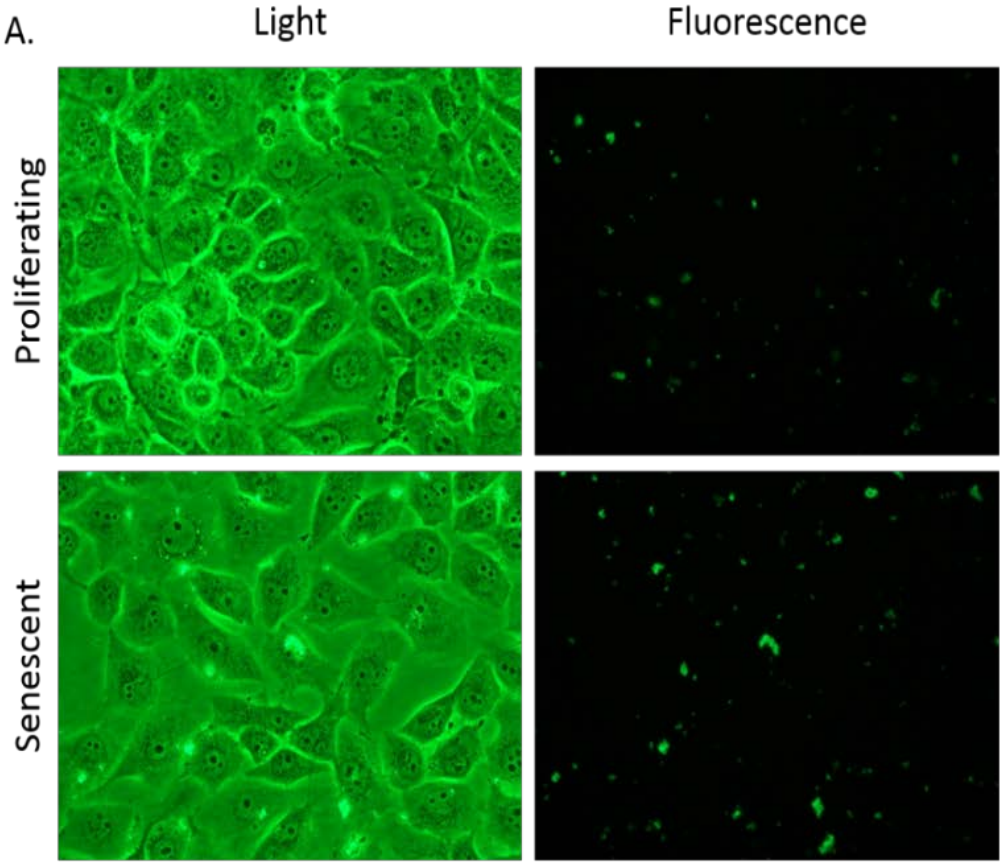
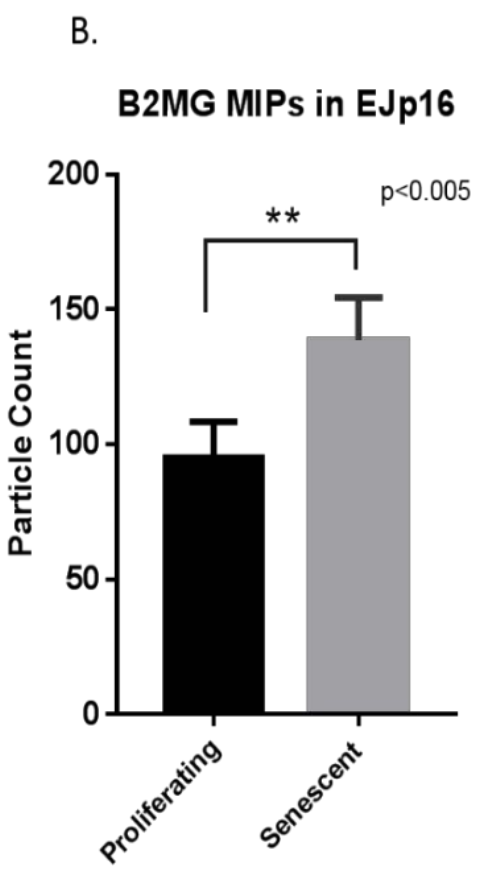
Targeting senescent cells

MIP nanoparticles synthesised for epitope of protein biomarker of cellular senescence. Nanoparticles were able to bind selectively to membrane receptor.





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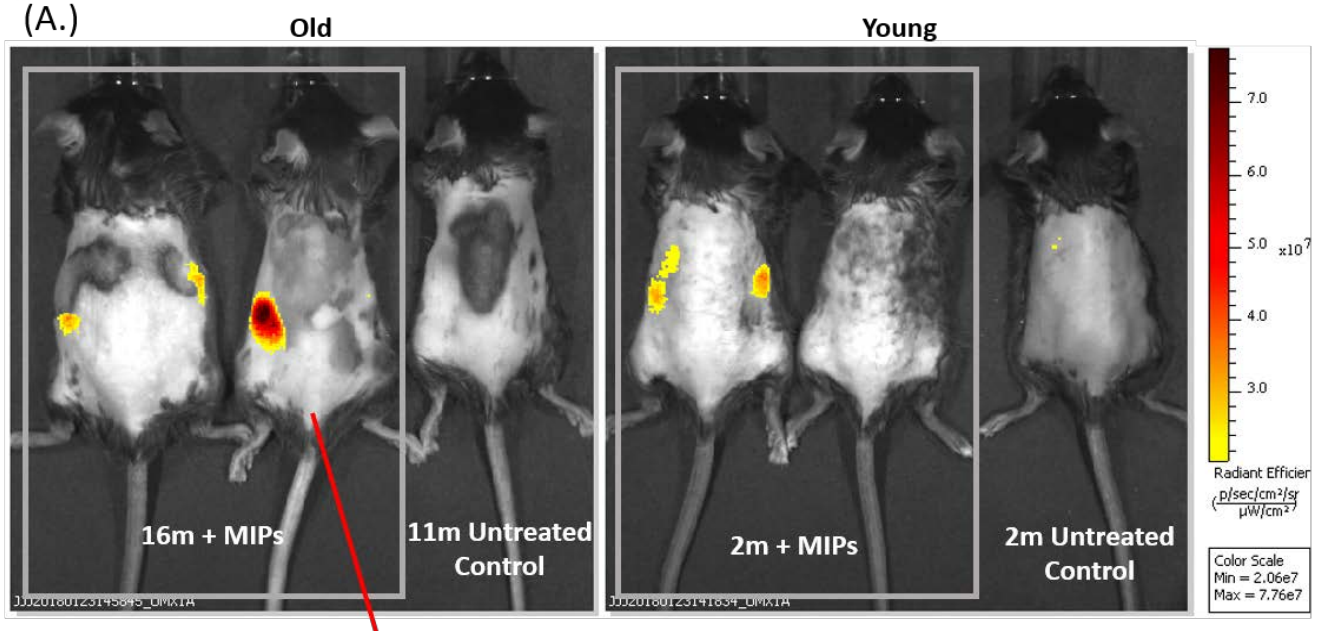
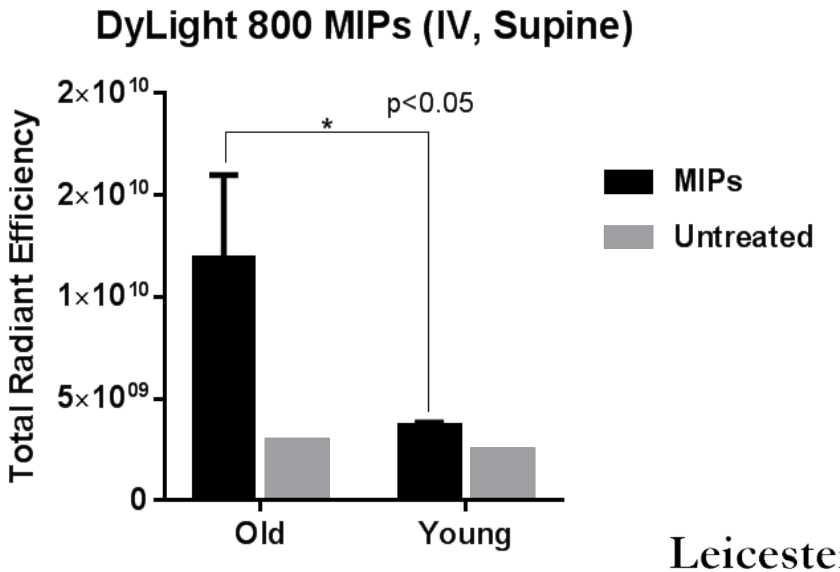
(A.)





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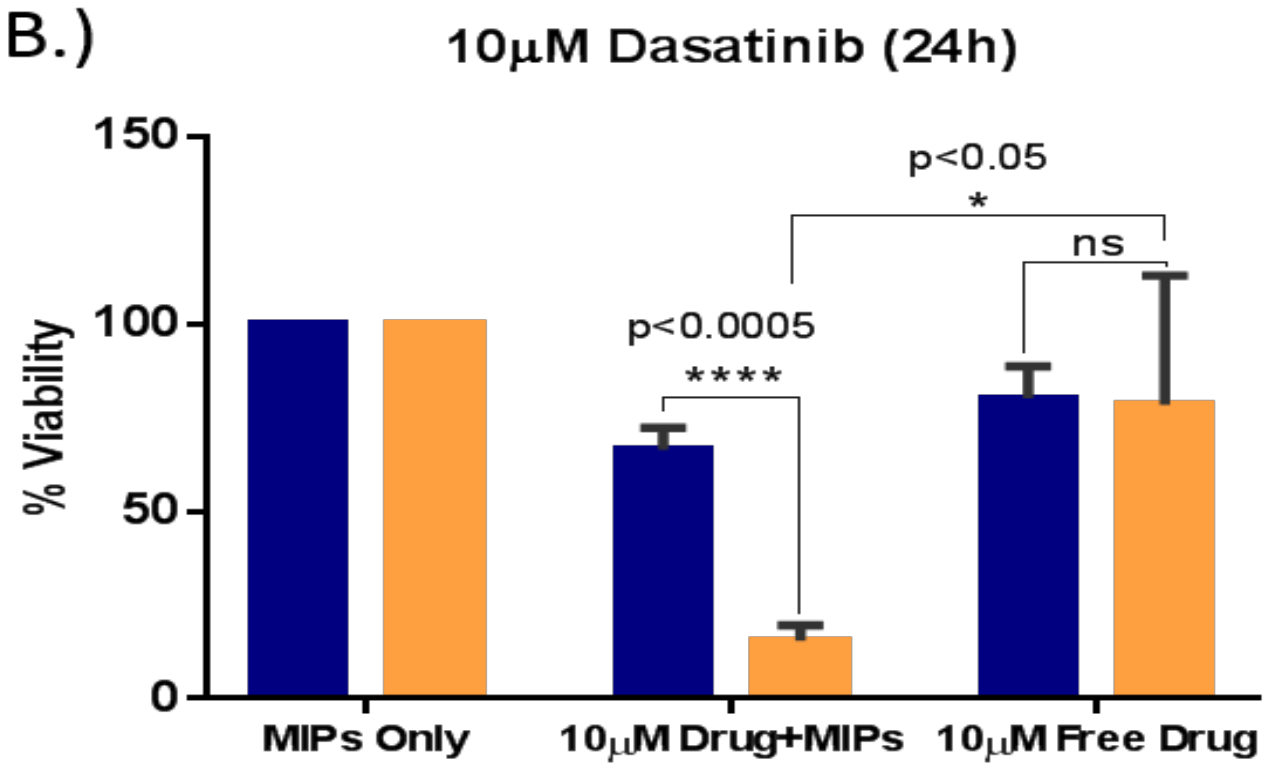
Therapeutic effect



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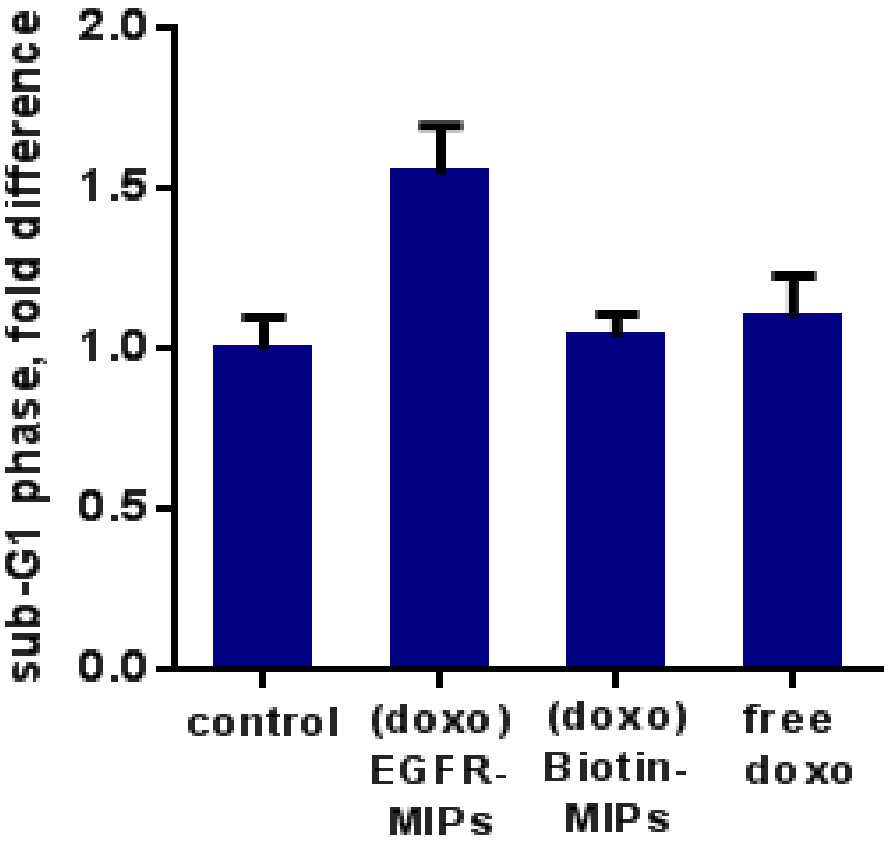
Therapeutic effect (anticancer)



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Fluorescent beacons for chemotherapy

- Treatment of cancer involves exposure of a tumour to high doses of radiation (radiotherapy) or chemicals (chemotherapy) that destroys cancerous cells.
- The results of this treatment usually become apparent weeks/ months after the treatment and are monitored via reduction of a tumour.
- At present, there is no reliable and fast approach to monitor the efficacy of radiotherapy and chemotherapy within the short term of exposure.

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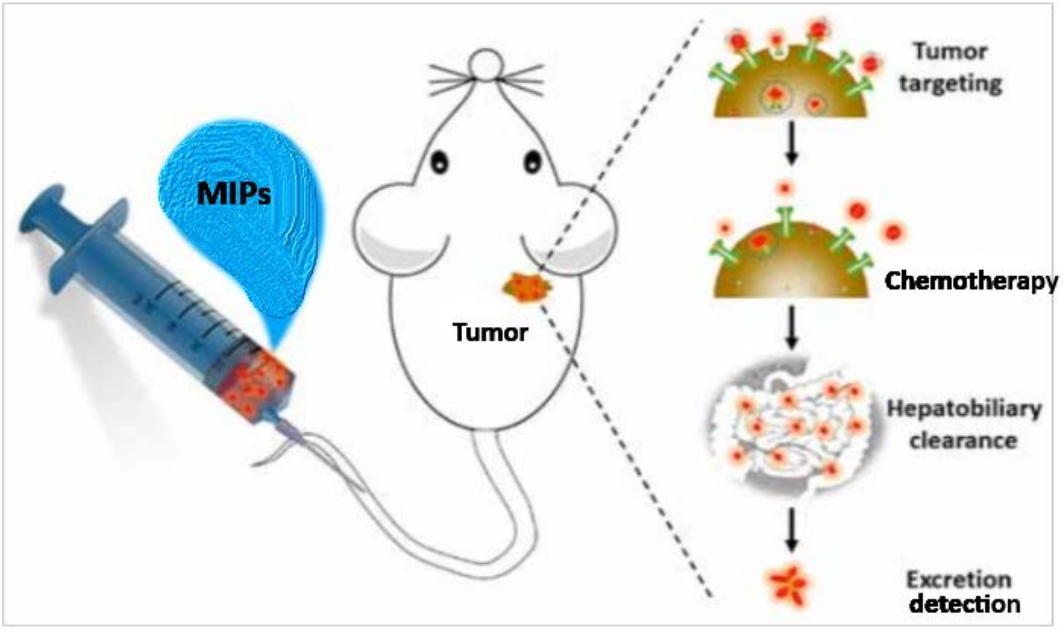
Fluorescent beacons



- The method proposed here involves development and application of specific “beacons” - fluorescent nanoMIPs that are attached to the cancerous cells and removed at the exposure to treatment dose.
- The concentration of nanoMIPs in urine and blood can be measured using optical fibre sensors to estimate the efficacy of treatment and enabling clinicians to optimise the treatment.

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Proposed work

The main objectives of the proposed work are:

- To develop fluorescent selective fluorescent beacons using MIPs technology that will bind to the cancerous cells and removed during the chemotherapy in the case of efficient reduction of the cancerous tissue;
- To develop a method of detection of the fluorescent beacons extracted from the body in the case of efficient reduction of the cancerous tissue using optical fibres;
- To validate developed method of monitoring efficiency of the cancer treatment using appropriate cancer model.

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Partners

Prof. S. Piletsky – MIP synthesis and characterisation

Prof. Steve Morgan's
Dr Sergiy Korposh
} - Optical sensors

? – Cell culture

? – Animal models

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Other projects

- Drug delivery
- Imaging
- Cell proteomics

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Team

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