

Short Review of the Last Two Years of Magnetic Carriers / 2014-2016

Urs Häfeli

The poster features a dark background with a grid of circular images. The central image is a globe showing a cityscape. Other images include various types of magnetic carriers, such as spherical particles with internal structures, and a large, complex, multi-layered structure resembling a virus or a large molecule. The text is in white and yellow.

11th
International Conference on the
Scientific and Clinical Applications
of Magnetic Carriers

imc FH KREMS
Wolfgang Schütt
Krems, Austria

Cleveland Clinic
Maciej Zborowski
Cleveland, Ohio, U.S.A.

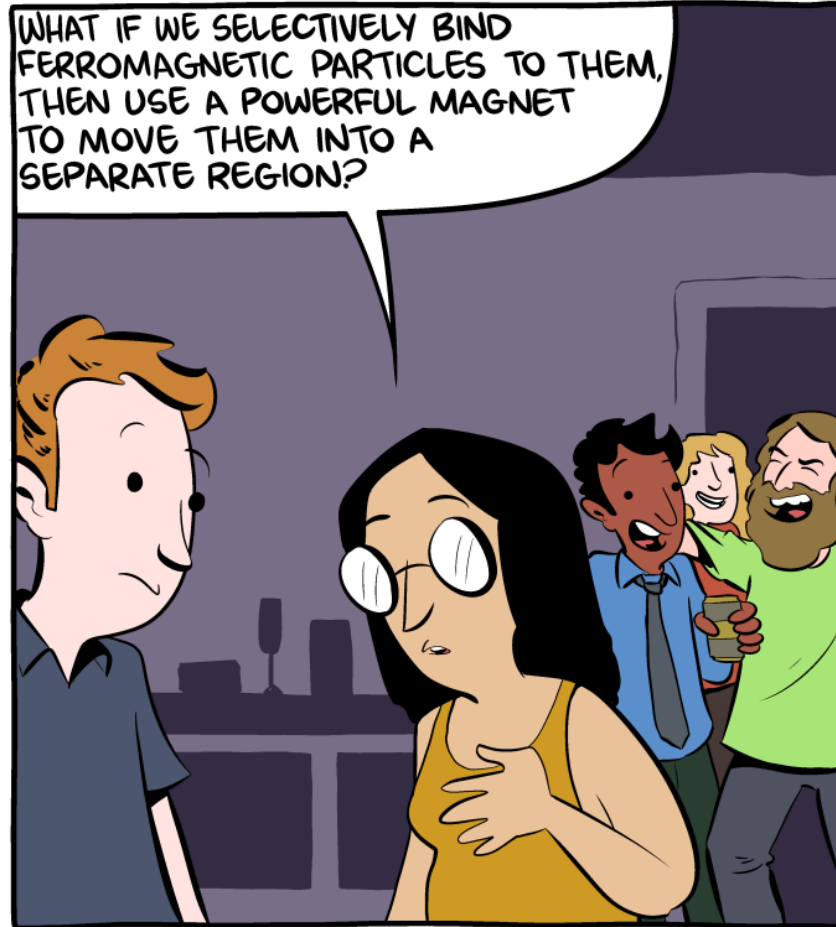
THE UNIVERSITY OF BRITISH COLUMBIA
Urs Häfeli
Vancouver, Canada

Vancouver, Canada | May 31-June 4, 2016
www.magneticmicrosphere.com



urs.hafeli@ubc.ca

We Hope Nobody Felt This Way at Our Reception Yesterday ...



Thanks to chemistry, we discovered the most subtle way to remove unwanted guests.

First Names – Please

Sie

vd

Vous

Du

YOU

First Names – Please



Urs

Hafeli

University of British Columbia

Canada

Just! You!

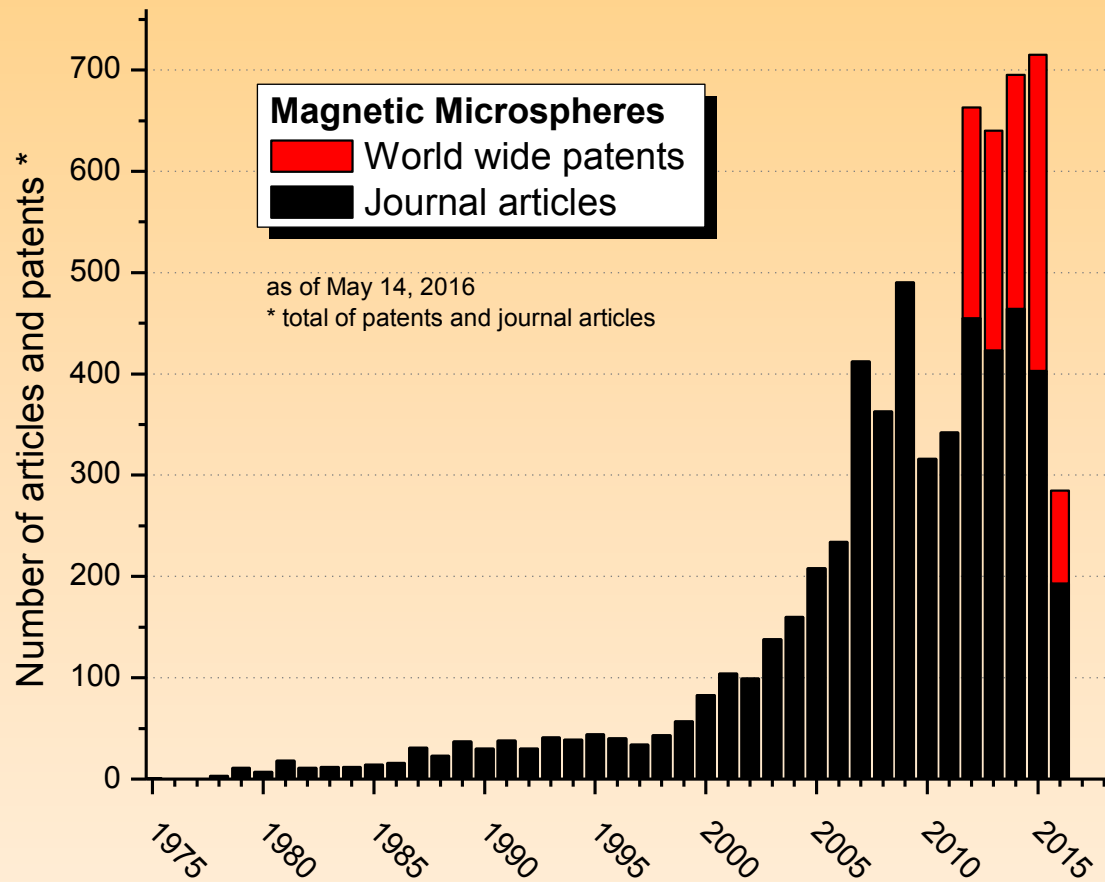
Thank You



Turn Cell Phones Off

Journal Update:

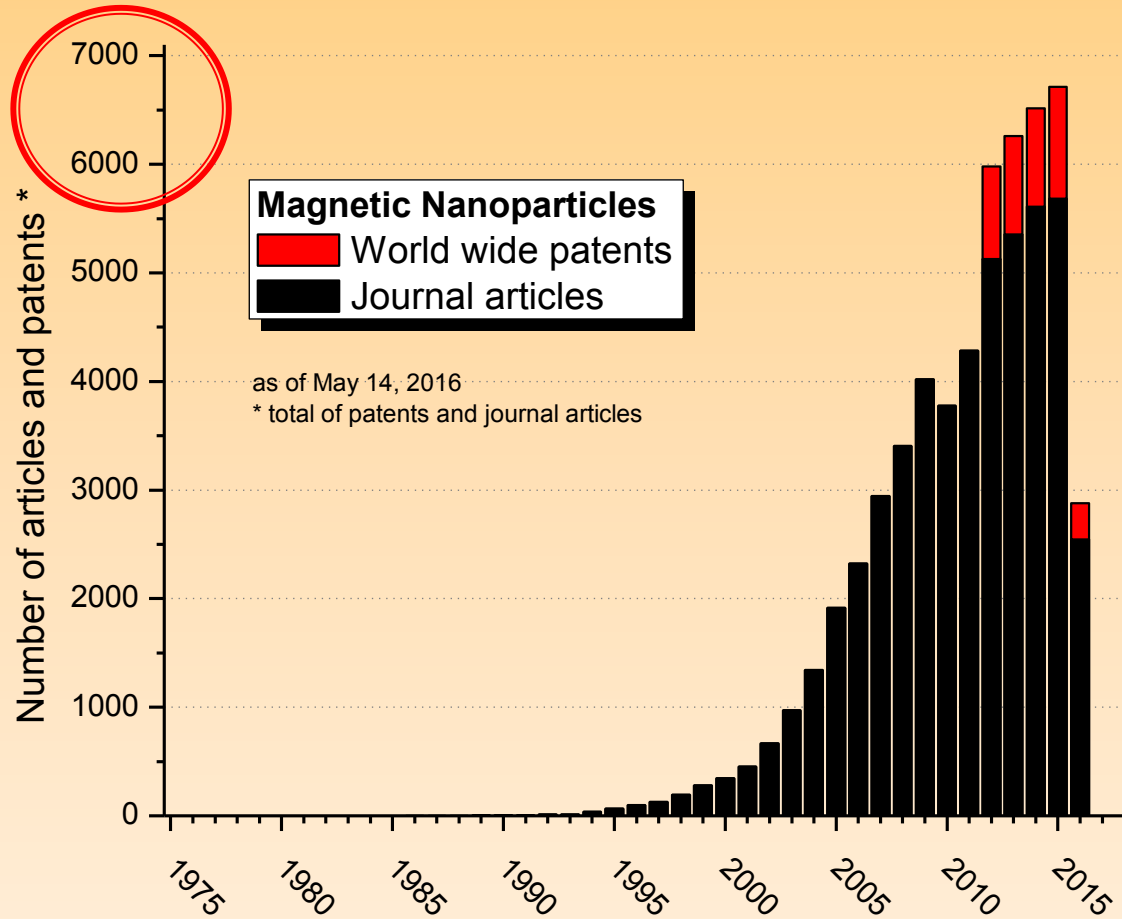
Is Publishing about Magnetic Microspheres Still Trendy ?



Journal Update:

Publishing about Magnetic Nanoparticles, That's Trendy !

Really true !



Another Side of Getting Old

- Emil Pollert from Prague died at the age of 75



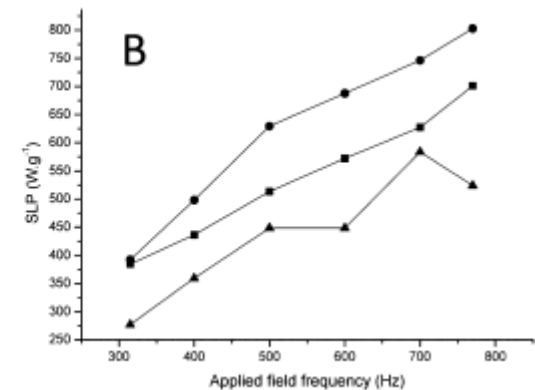
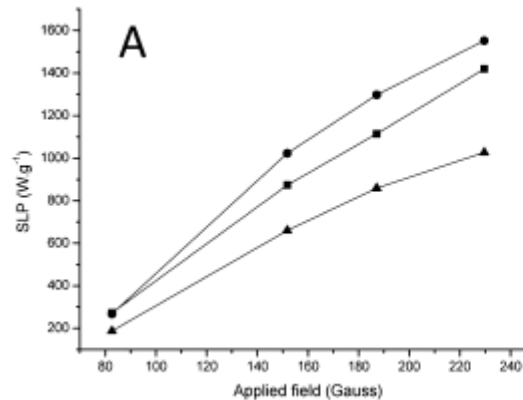
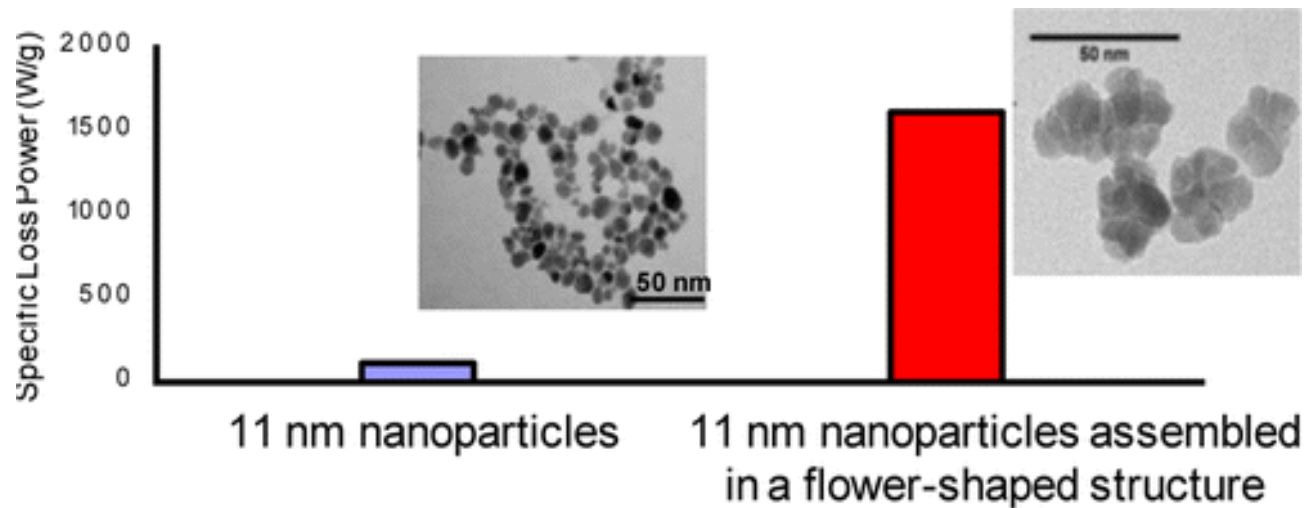
DISCLAIMER

- This presentation might be very incomplete, opinionated, one-sided, and might NOT mention your research
- But that's why you all have to stay around for the next 4 days ...



Synthesis

Nanoflowers



And Other Authors Also Seem to Like the Journal of Visualized Experimentation

BE Cell Labeling and Targeting with Superparamagnetic Iron Oxide Nanoparticles

Brandon J. Tefft¹, Susheil Uthamaraj², J. Jonathan Harburn³, Martin Klabusay⁴, Dan Dragomir-Daescu^{2,5}, Gurpreet S. Sandhu¹

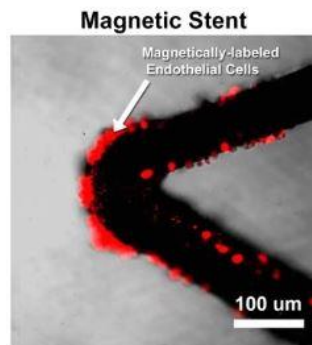
¹Division of Cardiovascular Diseases, Mayo Clinic, ²Division of Engineering, Mayo Clinic, ³School of Medicine, Pharmacy and Health, Durham University, ⁴Regional Center for Applied Molecular Oncology, Masaryk Memorial Cancer Institute, ⁵Mayo Clinic College of Medicine, Mayo Clinic

Article

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Metrics



jove

- 0:05 Title
- 1:24 Preparation of the Magnetite Gel
- 3:31 Purification of Magnetite Gel
- 4:29 Coating Nanoparticles with Poly(lactic-co-glycolic acid) (PLGA)
- 5:38 Labeling Cells with SPIONs
- 6:17 Results: Effective Synthesis of Superparamagnetic Iron Oxide Nanoparticles (SPIONs)
- 7:29 Conclusion

You have full access to this article through University of British Columbia.

Related Videos

- Formulation of Diblock Polymeric Nanoparticles...
Published 9/20/2011
- Ferromagnetic Bare Metal Stent for Endothelial...
Published 9/18/2015
- PLGA Nanoparticles Formed by Single- or...
Published 12/27/2013
- Synthesis of Immunotargeted Magneto-plasmonic...
Published 8/22/2014

Summary

Targeted cell delivery is useful in a variety of biomedical applications. The goal of this protocol is to use superparamagnetic iron oxide nanoparticles (SPION) to label cells and thereby enable magnetic cell targeting

Translate text to:

Choose Language...

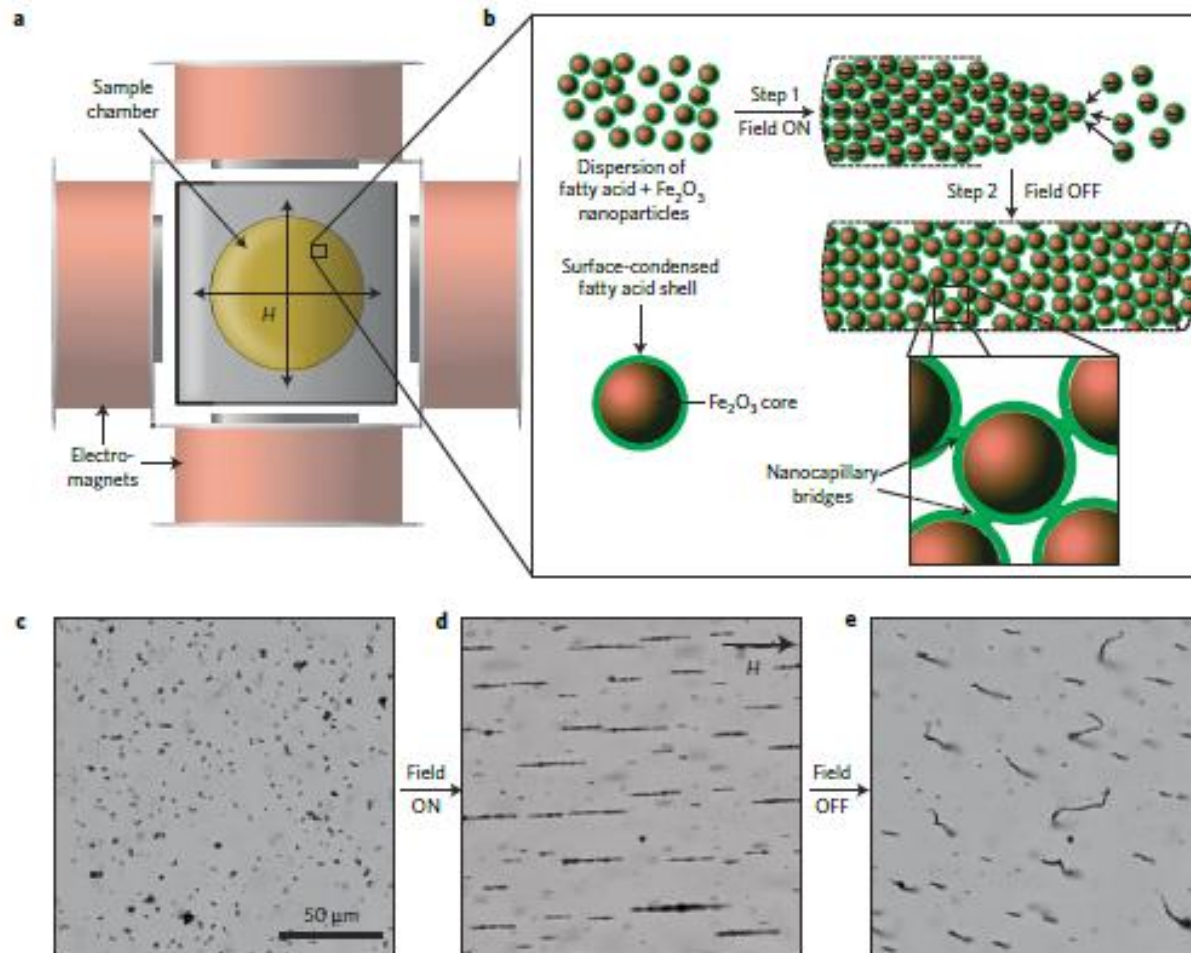
العربية (Arabic)

中文 (Chinese)

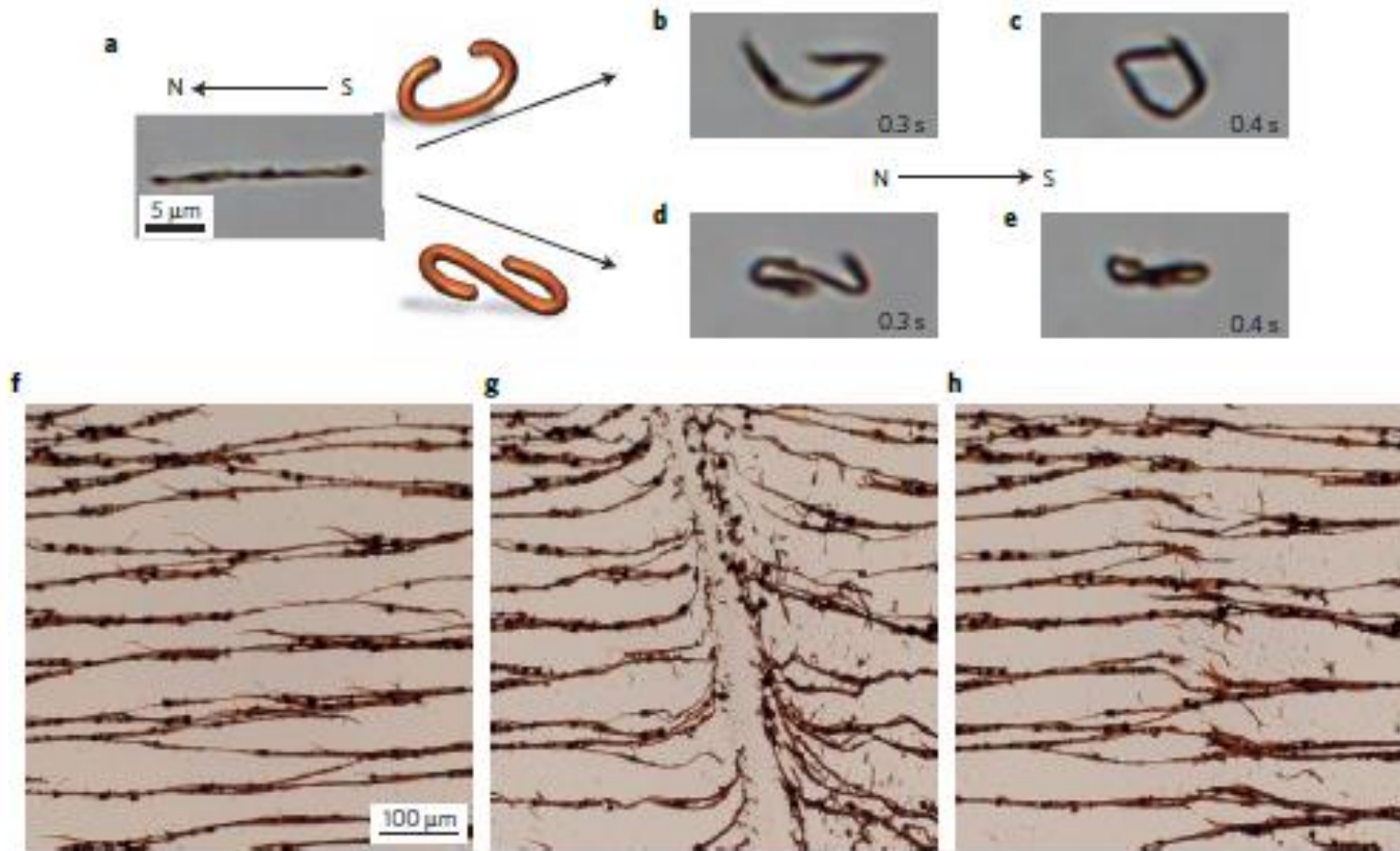
dansk (Danish)

Tefft, B. J., Uthamaraj, S., Harburn, J. J., Klabusay, M., Dragomir-Daescu, D., Sandhu, G. S. Cell Labeling and Targeting with Superparamagnetic Iron Oxide Nanoparticles. *J. Vis. Exp.* (104), e53099, doi:10.3791/53099 (2015).

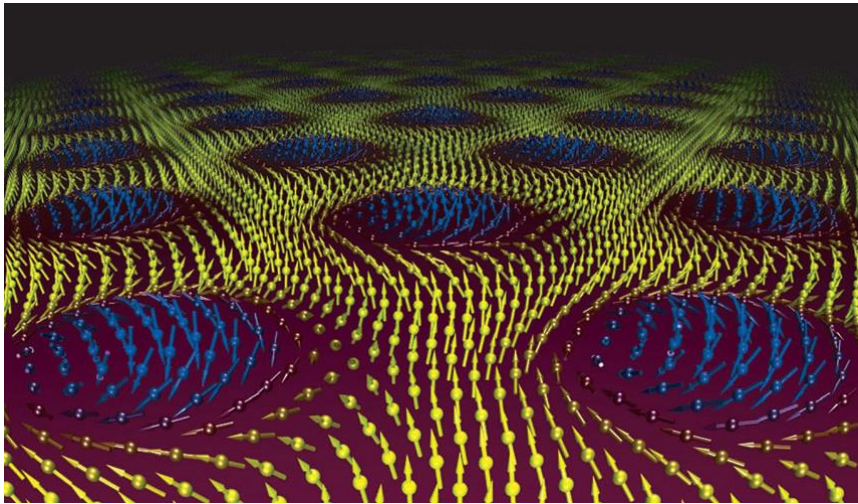
Self-Healing Magnetic NP Chains



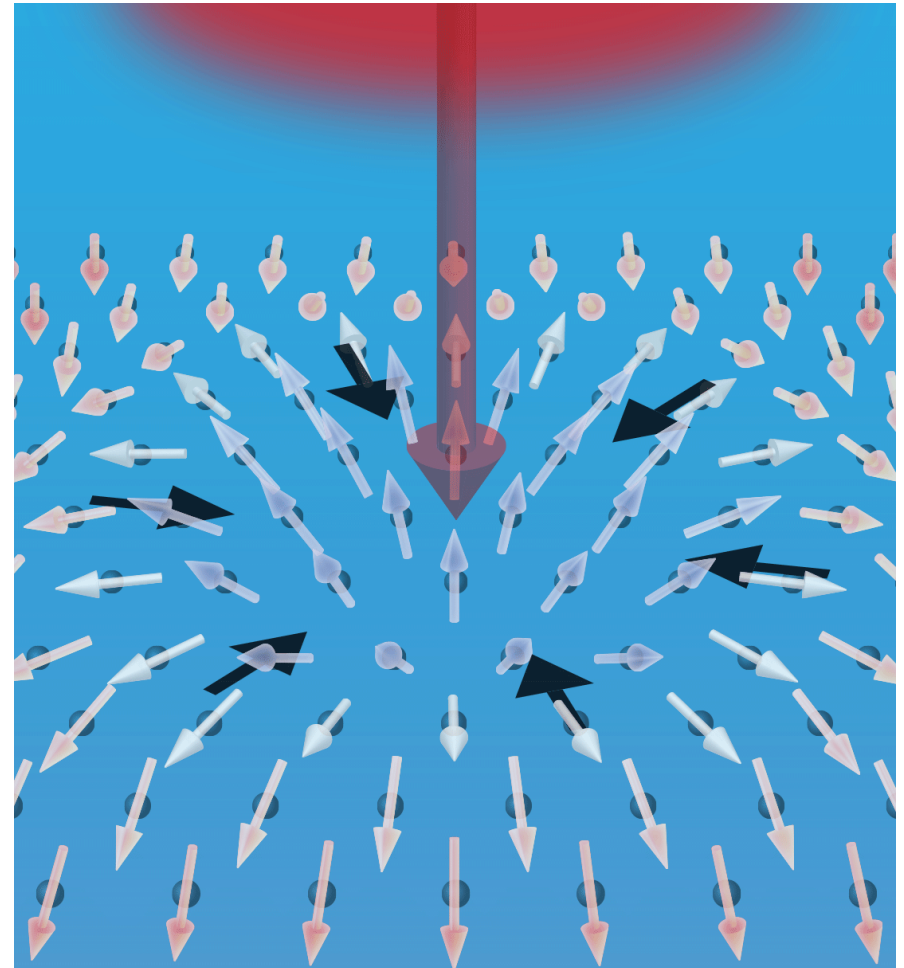
Self-Healing Magnetic NP Chains



Skyrmions Made Me Squirm



Felser C (2013). Skyrmions. *Angew Chem Int Ed Engl* 52, 1631-1634



Romming N et al. (2015). *Phys. Rev. Lett.* **114**, 17720

Rewriteable Magnetic Charge Ice

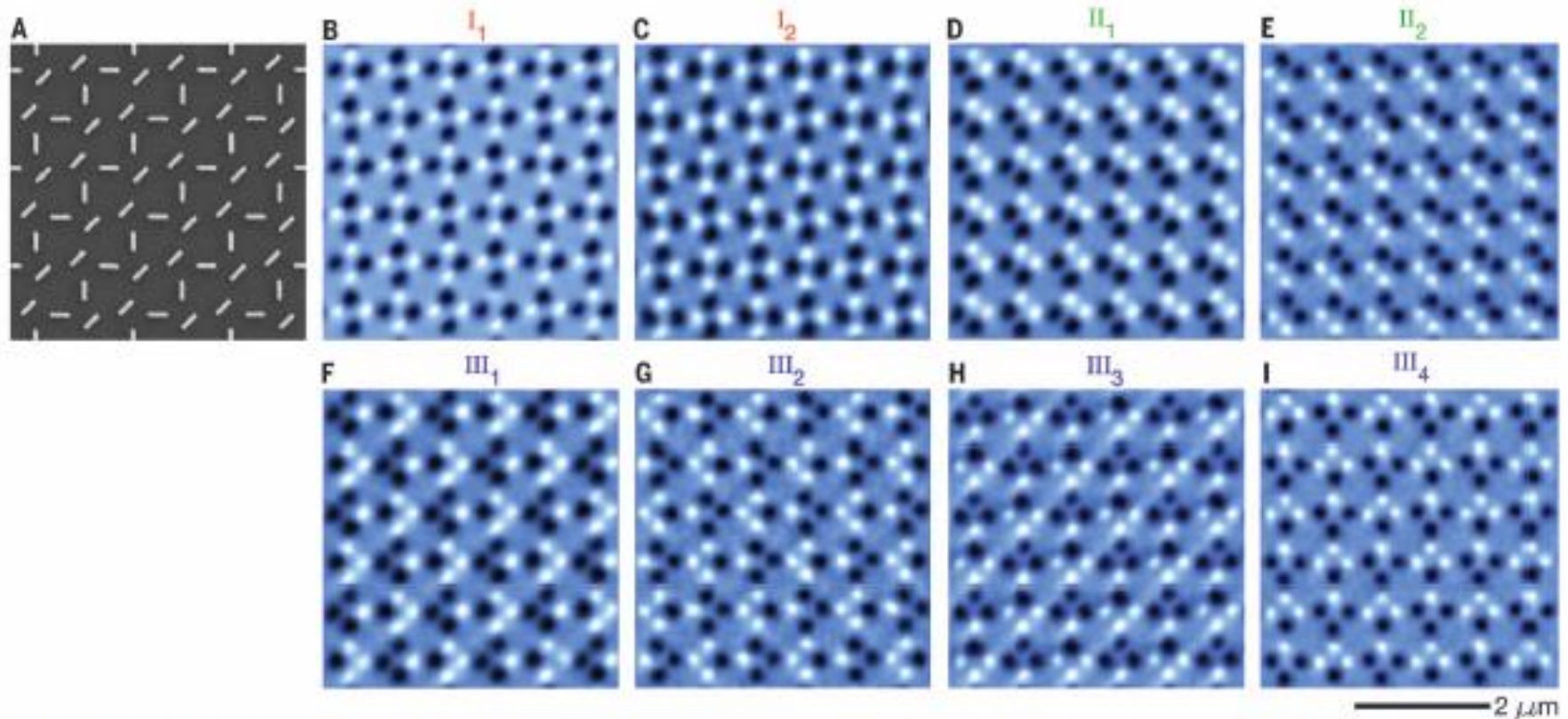


Fig. 2. Realization of magnetic charge ices. (A) Scanning electron microscopy image of permalloy ($\text{Ni}_{80}\text{Fe}_{20}$) magnetic islands (300 nm long, 80 nm wide, and 25 nm thick). (B to I) Magnetic force microscopy images of the various ordered states corresponding to all of the configurations in Fig. 1G. (B and C) Twofold degenerate type I ground states: I_1 (B) and I_2 (C). (D and E) Twofold degenerate excited type II states: II_1 (D) and II_2 (E). (F to I) Fourfold degenerate excited type III states: III_1 (F), III_2 (G), III_3 (H), and III_4 (I). The lift height of the MFM scanning is 100 nm.

Rewriteable Magnetic Charge Ice

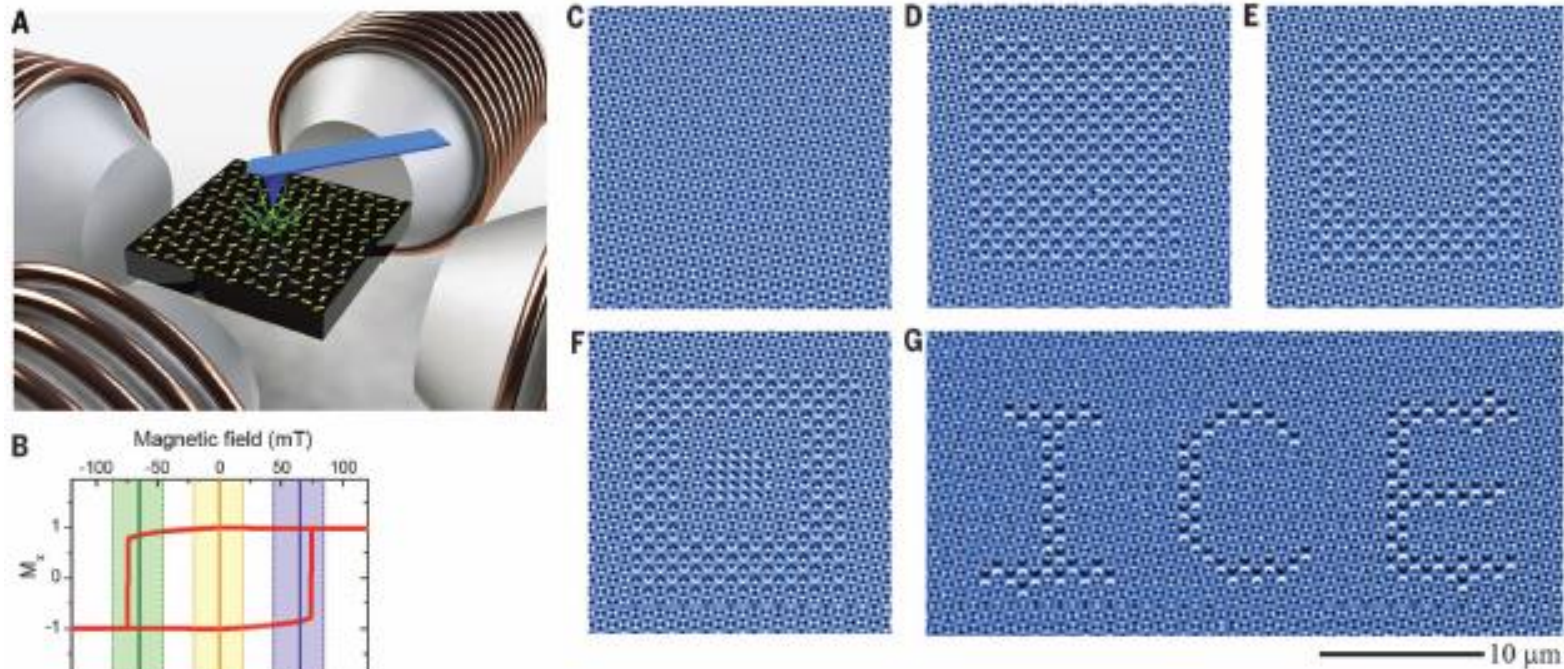
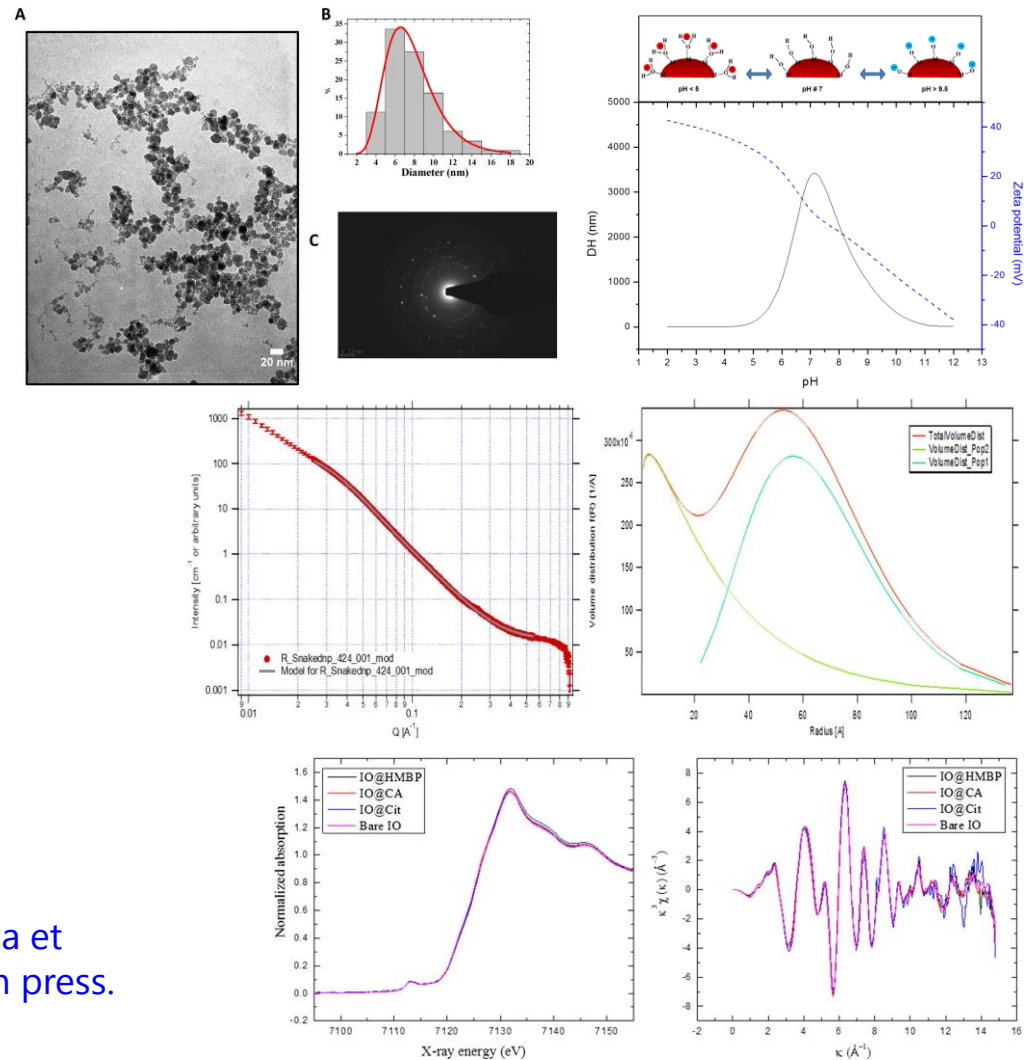


Fig. 3. Rewriteable magnetic charge ices. (A) Sketch of the experimental setup: an MFM equipped with a 2D vector magnet. The 2D solenoid magnet provides magnetic fields in any desired orientation in the sample plane. The vertically magnetized MFM probe generates a stray magnetic field (green arrows) with in-plane components at the tip. (B) Magnetization loop of a single magnetic island, with an illustration of the write, erase, and read functions. M_x , magnetization along the island. (C to G) Magnetic force microscopy images of the patterned magnetic charge ice at the same area of the sample. (C) The initial state is a type I₁ state. (D) A square area of a type III₃ state was written in the center of (C). (E) A smaller square region of type III₃ order was erased back to a type I₁ state from (D). (F) A round region of type II₂ order was written onto the freshly erased area from (E). (G) "ICE" letters of type III₄ states were scribed on a type I background state.

Coating

Look Closely – By X-Ray Synchrotron

- TEM, DLS and Zetapotential are fine methods
- But SAXS, XANES and EXAFS are even finer!



Milosevic I, Motte L, et al. (2016). *Biochimica et Biophysica Acta (BBA) - General Subjects*, in press.

Technical Applications

MPI



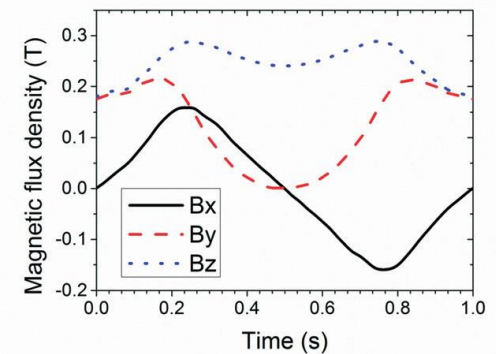
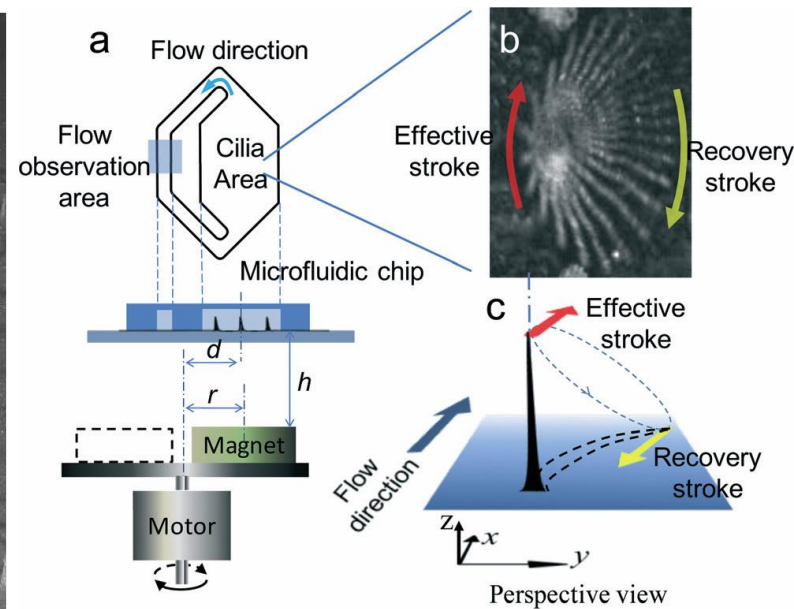
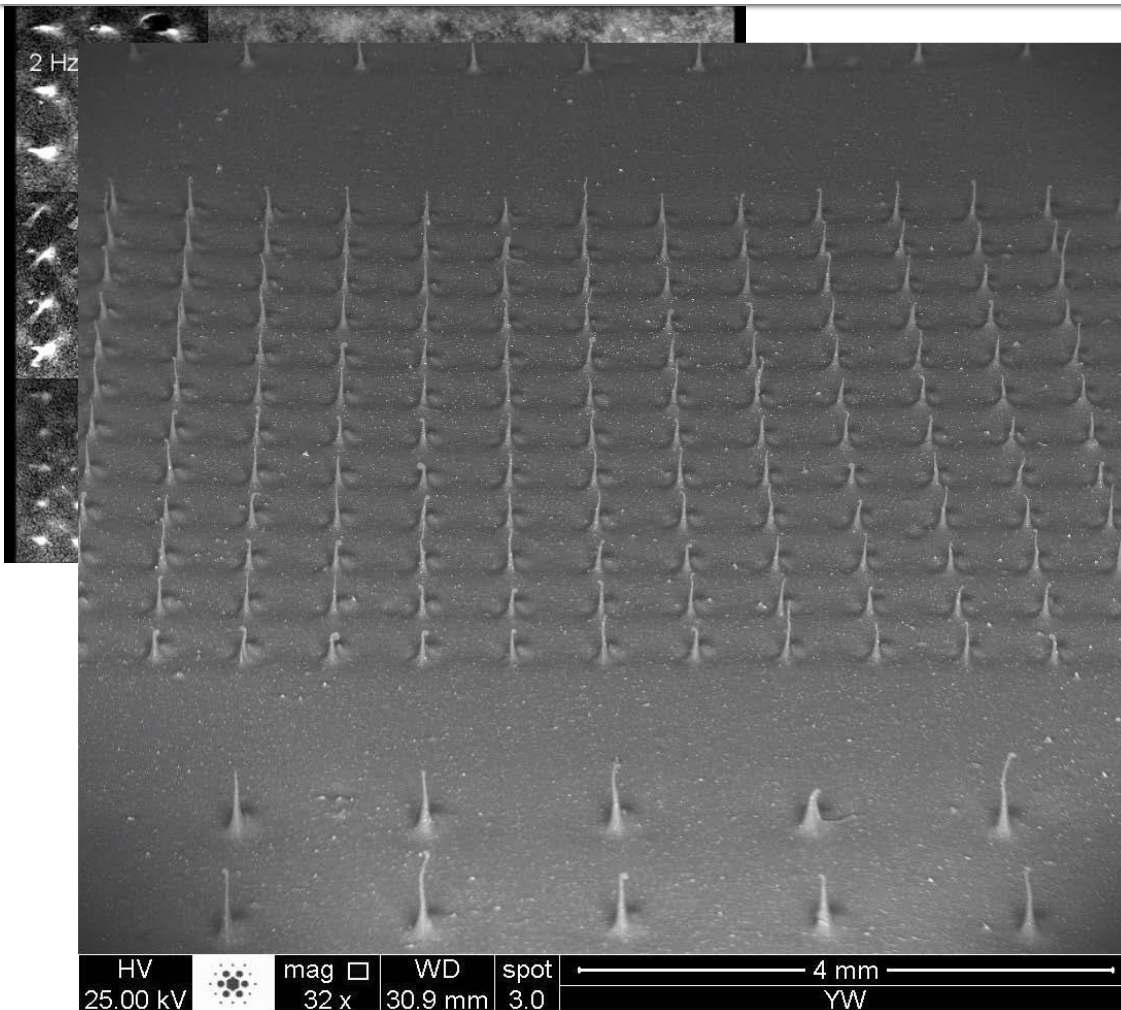
Go to magneticmicrosphere.com and make them the **European Inventors of 2017** !

MPI Instrument from Philips

- \$3 Mio, now from Bruker
- Already installed in
 - Hamburg
 - Berlin
 - Aachen
 - Lübeck
 - Prague
- Mice can be imaged

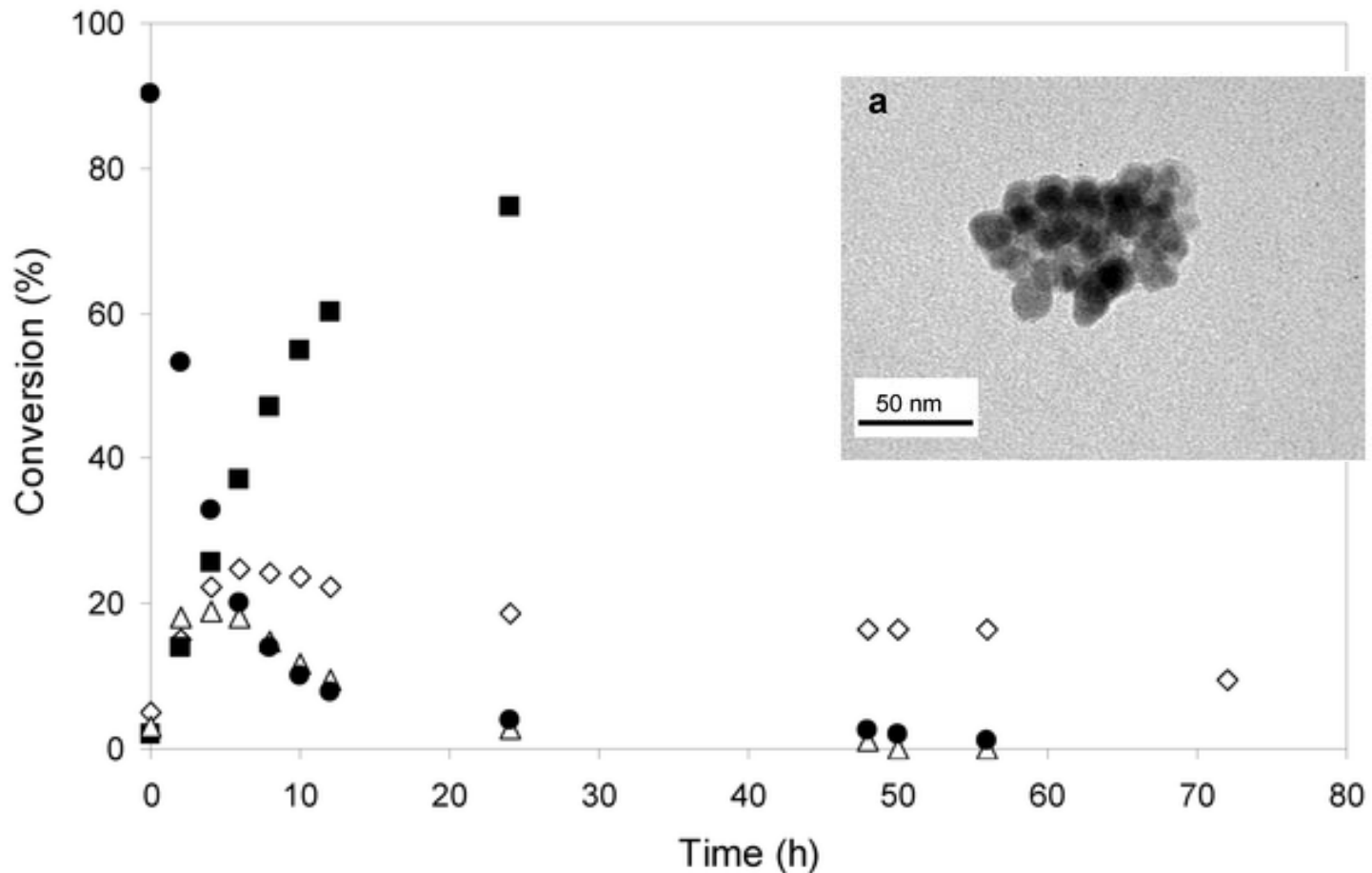


Magnetic Artificial Cilia



Wang Y, den Toonder J, et al. (2016). Lab on a chip, in press

Time-Course of Biodiesel (FAPEs) Conversion Catalyzed by MNPs

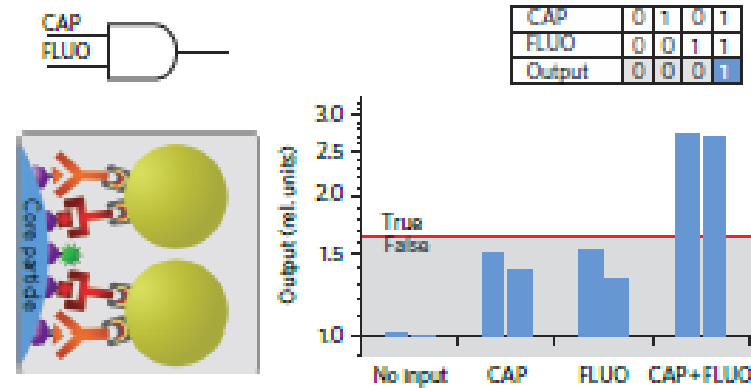


Cruz-Izquierdo Á, Picó EA, López C, Serra JL, et al. (2014) Magnetic Cross-Linked Enzyme Aggregates (mCLEAs) of *Candida antarctica* Lipase: An Efficient and Stable Biocatalyst for Biodiesel Synthesis. PLoS ONE 9(12): e115202. doi:10.1371/journal.pone.0115202 <http://www.plosone.org/article/info:doi/10.1371/journal.pone.0115202>

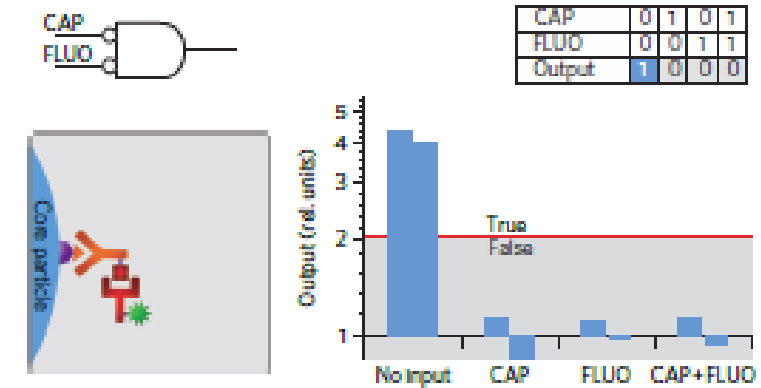
Biological Applications

Biocomputing Based on Particle Disassembly

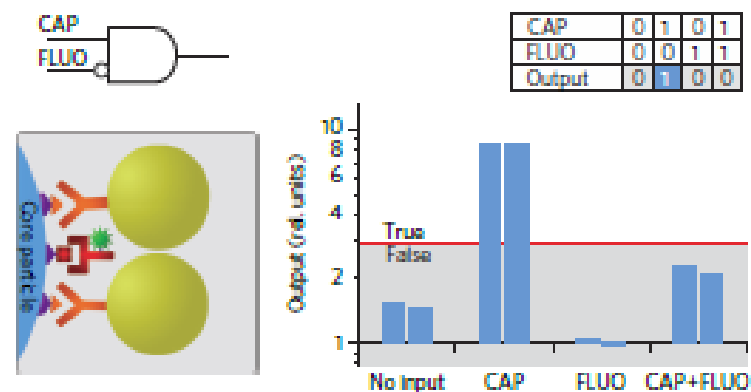
a (YES CAP) AND (YES FLUO) \equiv AND gate



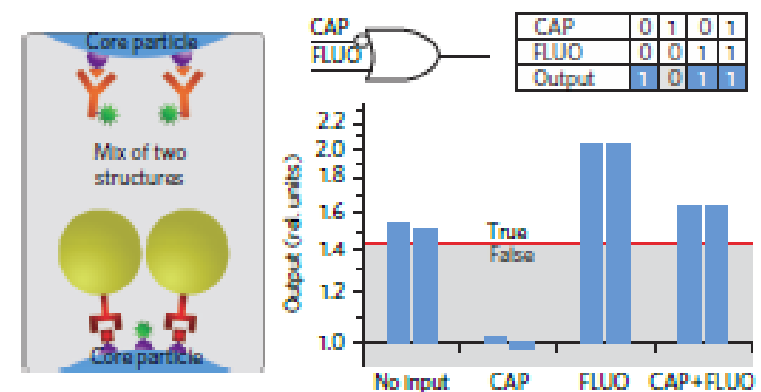
c (NOT CAP) AND (NOT FLUO) \equiv NOR gate



b (YES CAP) AND (NOT FLUO) \equiv INHIBIT gate

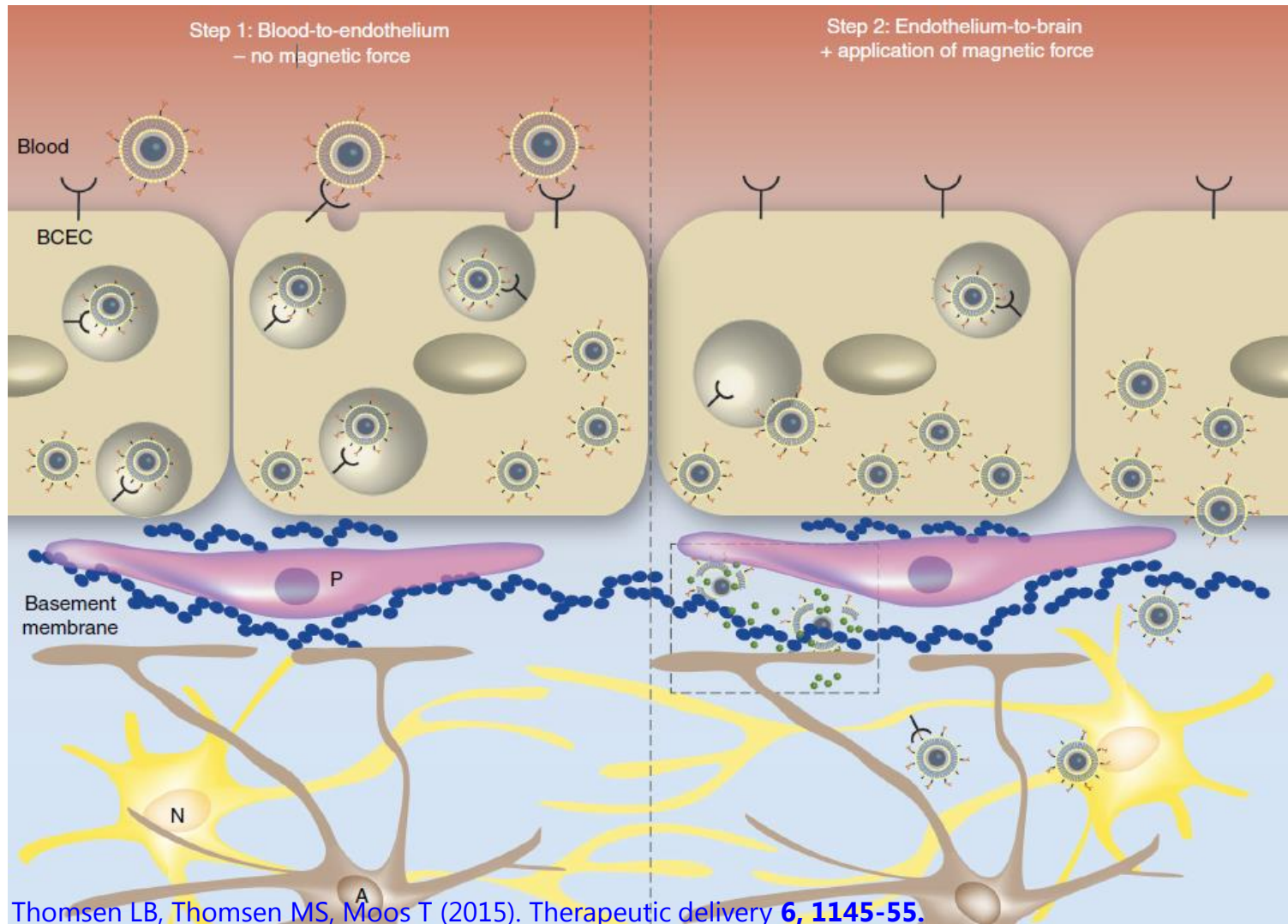


d (NOT CAP) OR (YES FLUO) \equiv IF-THEN gate



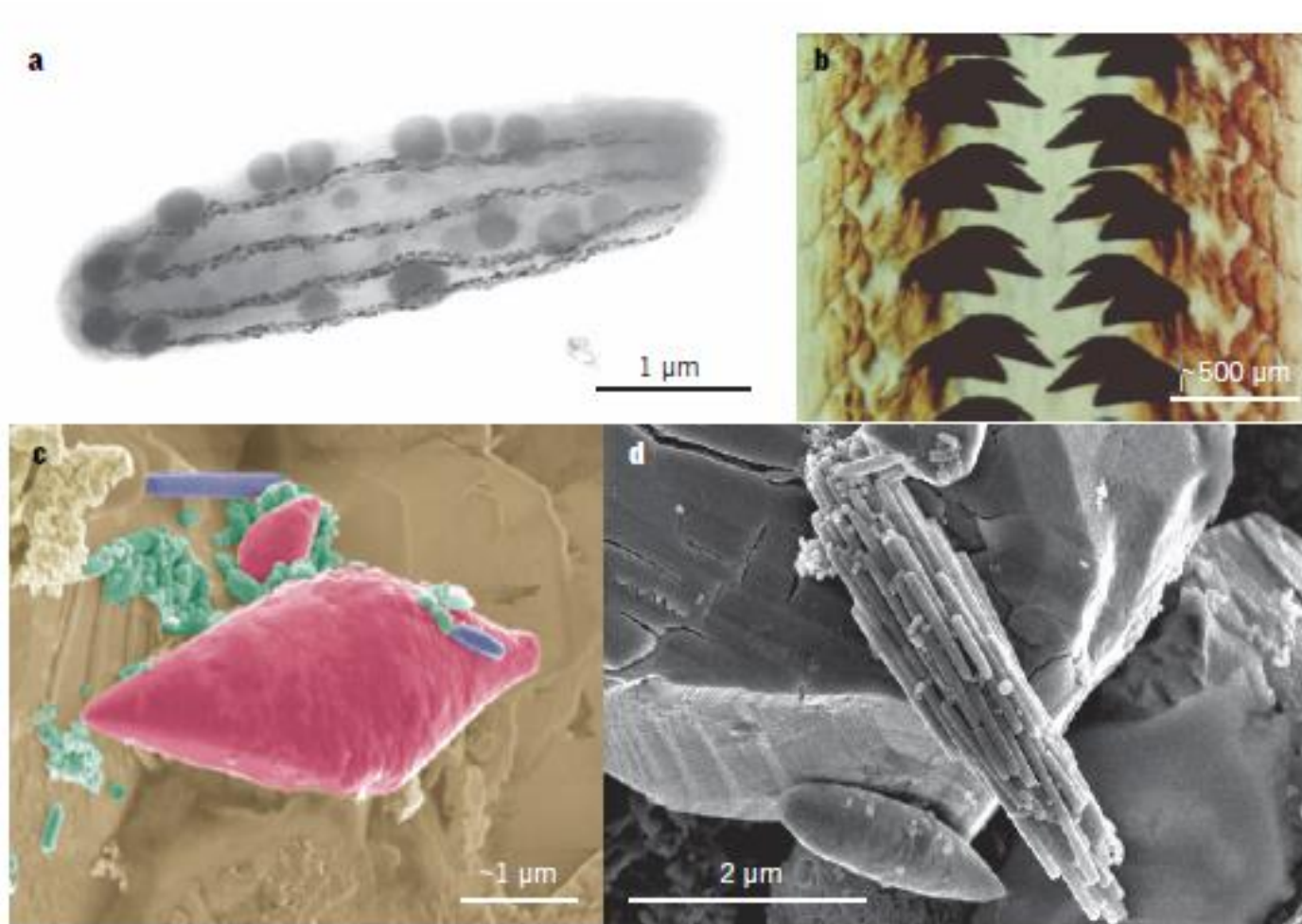
Shielding particle
 Protein A/IgG
 BSA
 Biotin label
 Interfaces:
 Anti-CAP IgG
 CAP label
 Anti-FLUO IgG
 FLUO label
 Inputs:
 Free CAP
 Free FLUO

Targeted Drug Delivery to the Brain with MNPs



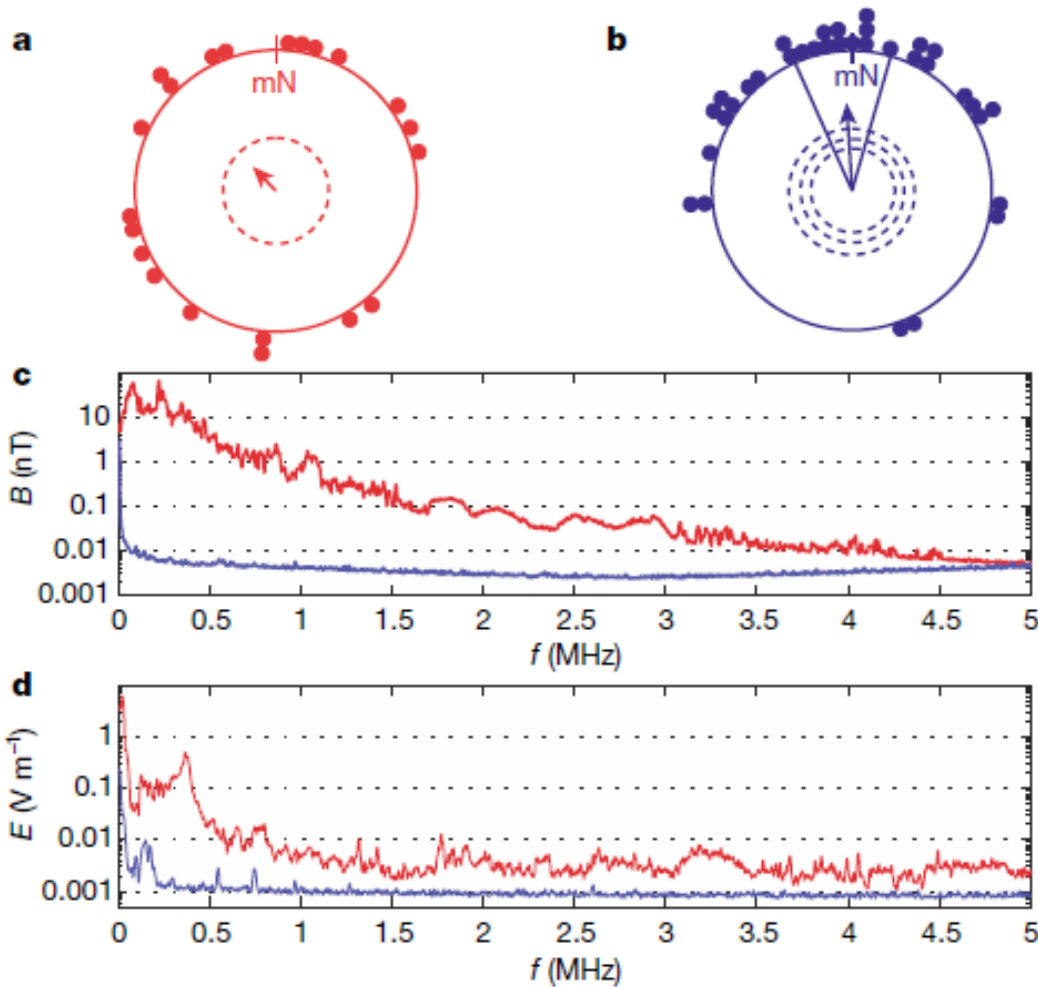
Thomsen LB, Thomsen MS, Moos T (2015). Therapeutic delivery **6**, 1145-55.

Anthropogenic Magnetism

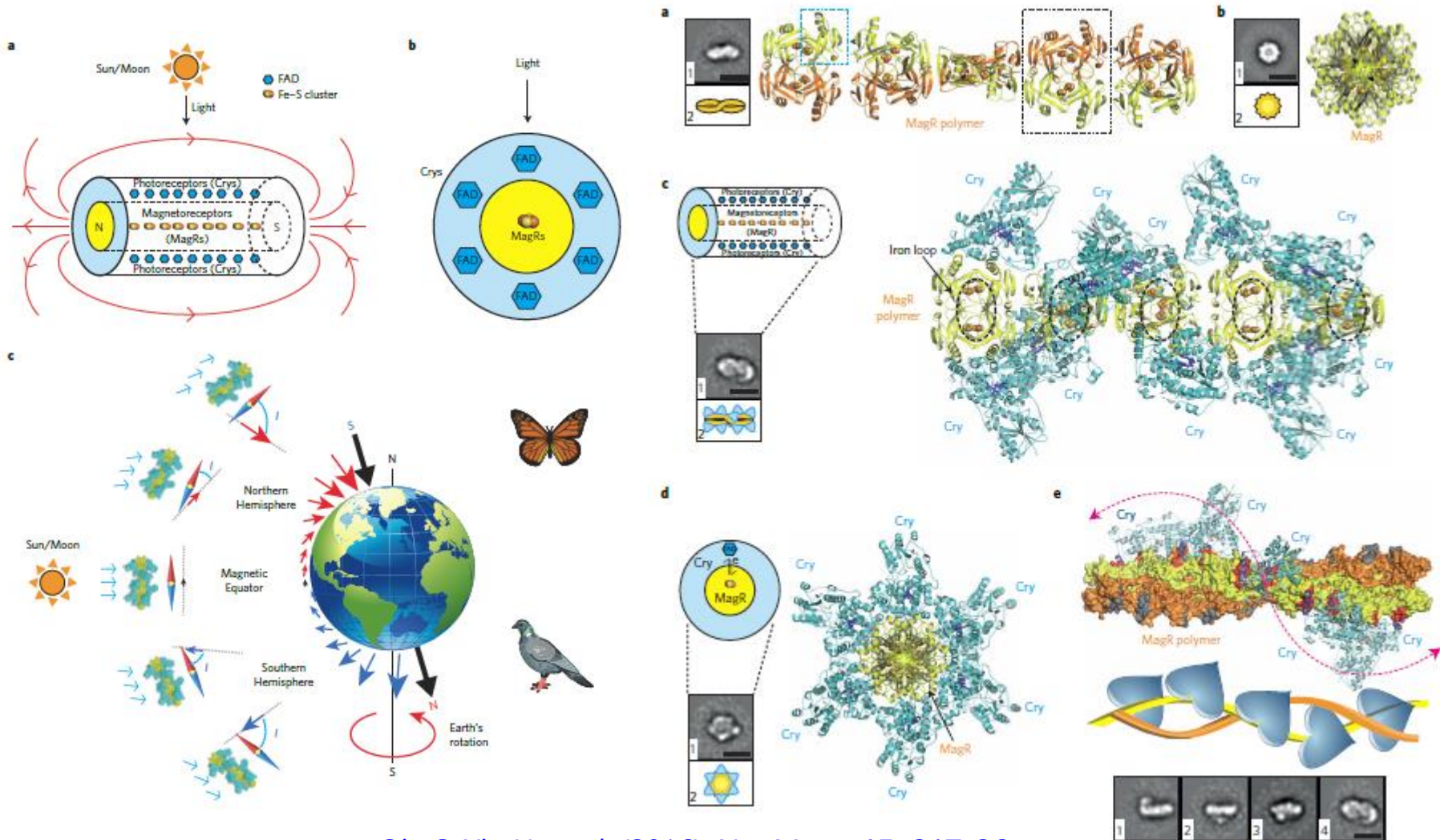


A, MARIANNE HANZLIK; B, HEINZ A. LOWENSTAM; JOSEPH L. KIRSCHVINK; C, D, DIRK SCHUMANN

Anthropogenic Magnetism

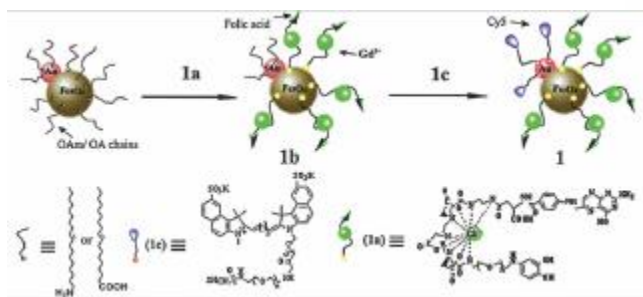
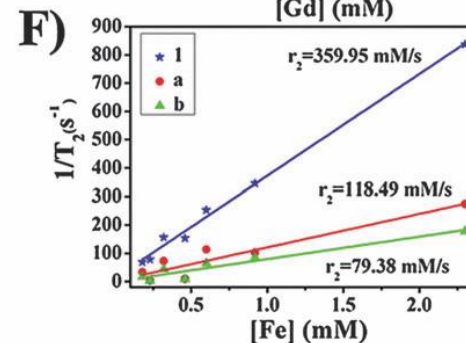
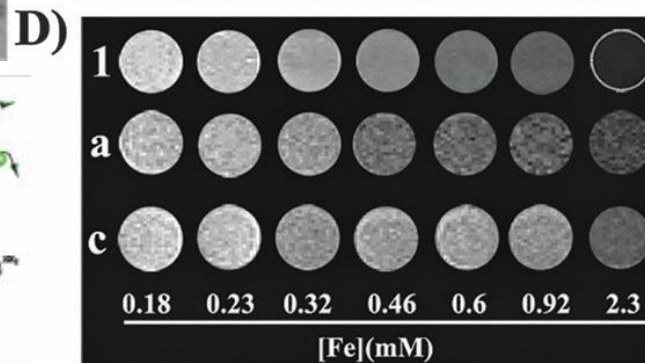
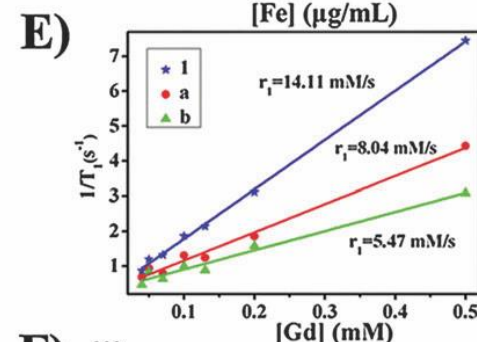
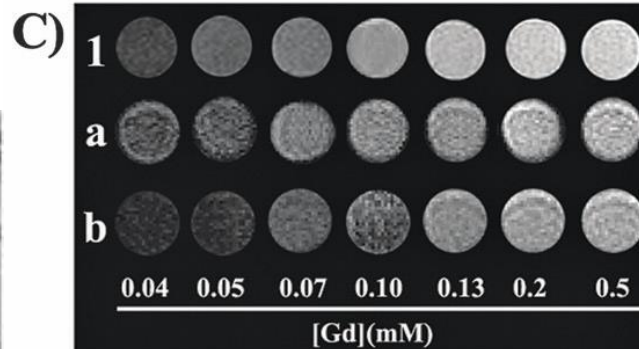
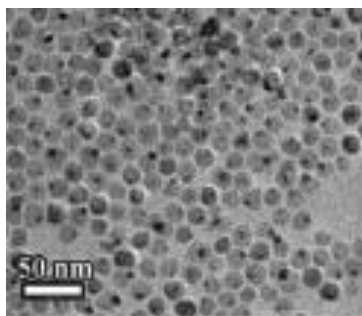
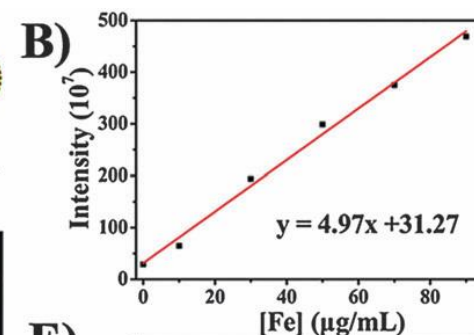
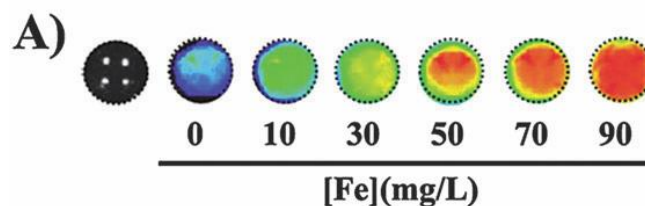


A Magnetic Protein Biocompass

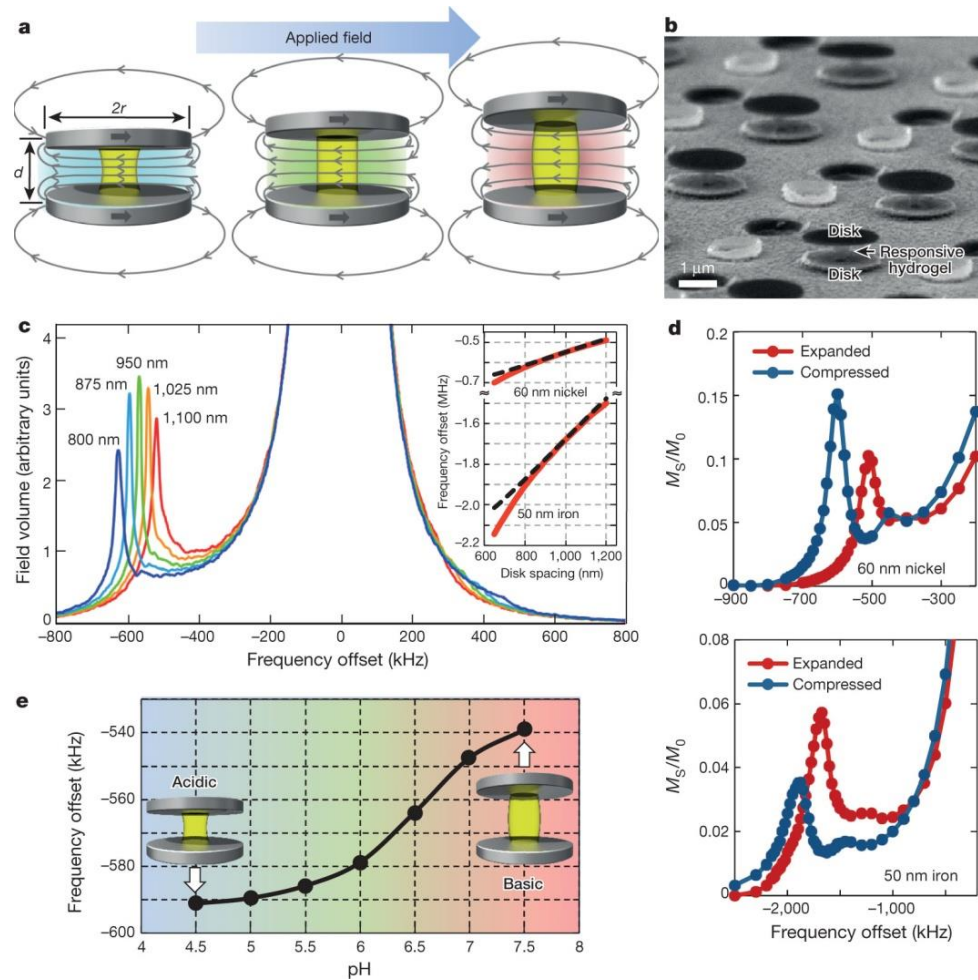


NIR and MRI Multimodal Imaging

- NIR imaging at the same time as MRI with concurrent T1 and T2 contrast
- Nicely applied surface chemistry



Principles of Shape-Changing RF Colorimetric Sensors



G Zabow *et al.* *Nature* **520**, 73-77 (2015)

Medical Applications

Magnetic Particles in Animal Models

M Experimental Glaucoma Induced by Ocular Injection of Mag

Shannon Bunker¹, Joanna Holeniewska¹, Sauparnika Vijay², Annegret Dahlmann-Noor^{2,3}, Peng Khaw^{2,4}, Yin-Shan Ng⁵, Da

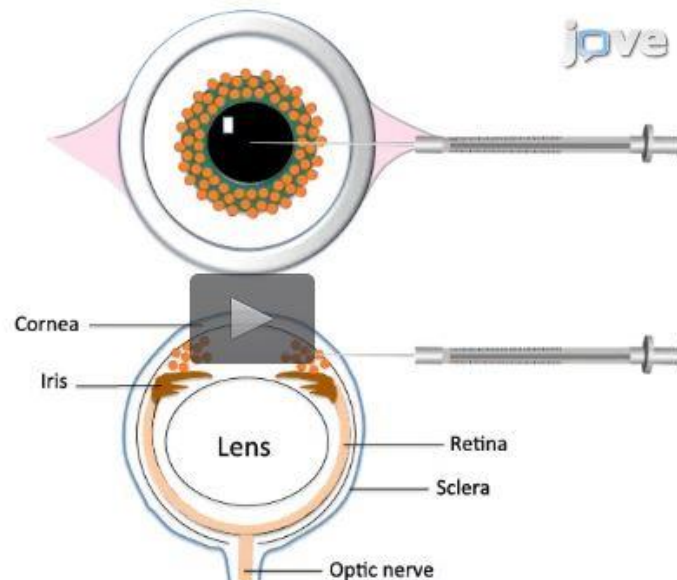
¹Ocular Biology and Therapeutics, University College London Institute of Ophthalmology, ²University College London Hospital, ⁴NIHR Biomedical Research Centre, Moorfields Eye Hospital, ⁵Schepens Eye Research Institute, Harvard Medi

Article

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0:05 Title

0:57 Ocular Hypertension Induction

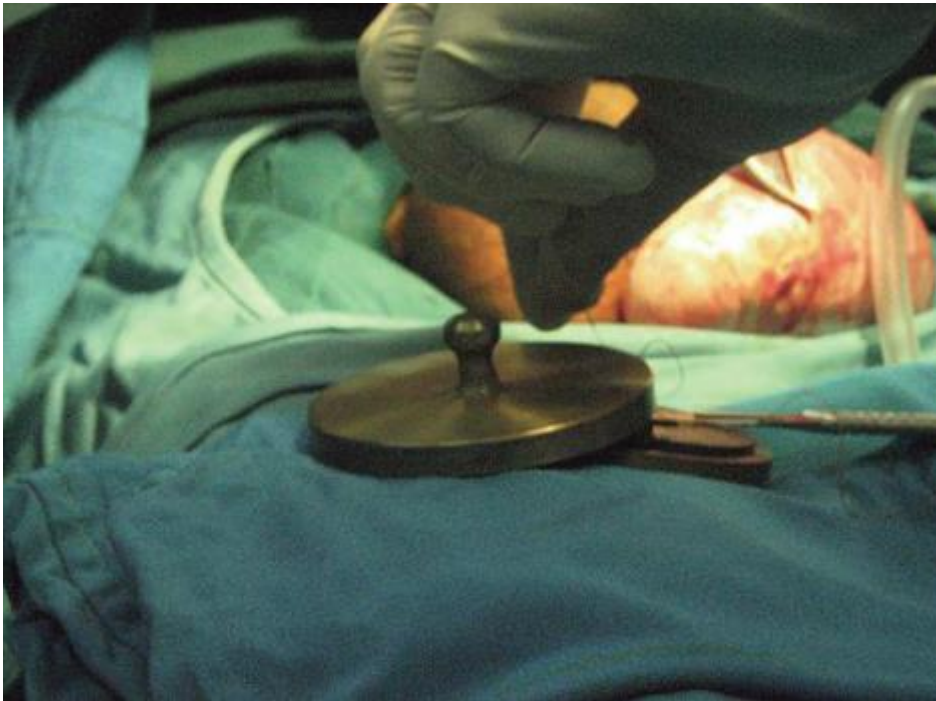
4:40 Results

00:32

06:35

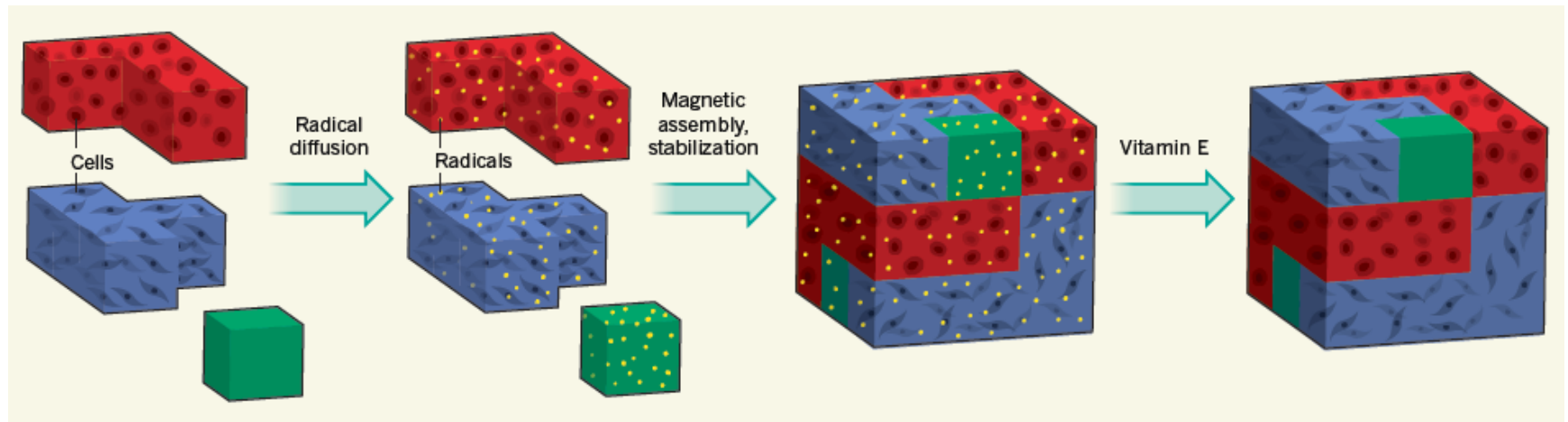
Bunker, S., Holeniewska, J., Vijay, S., Dahlmann-Noor, A., Khaw, P., Ng, Y. S., et al. Experimental Glaucoma Induced by Ocular Injection of Magnetic Microspheres. *J. Vis. Exp.* (96), e52400, doi:10.3791/52400 (2015).

Magnets in Surgery



Rahmati H, Sharif F, Davarpanah MA (2014). Nigerian medical journal 55, 220-3

Radicals Promote Magnetic Gel Assembly



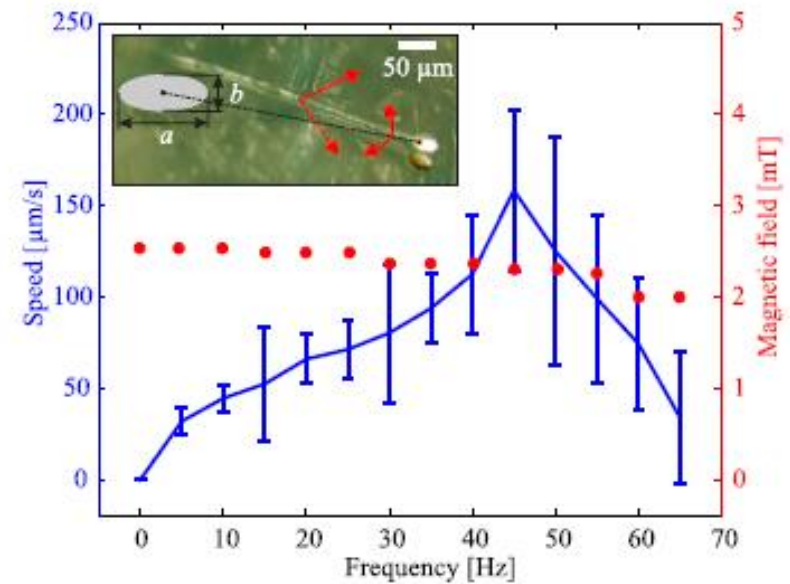
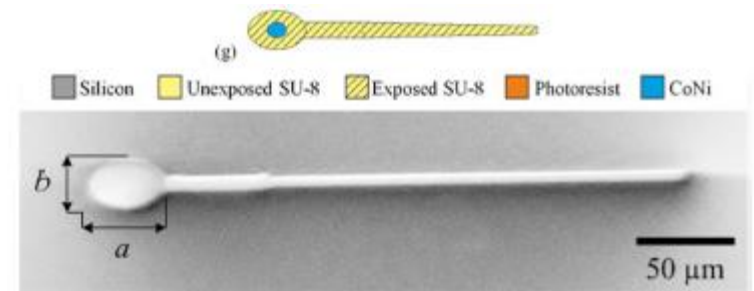
Rodell CB, Burdick JA (2014). *Nature* **514**, 574-5

MagnetoSperm



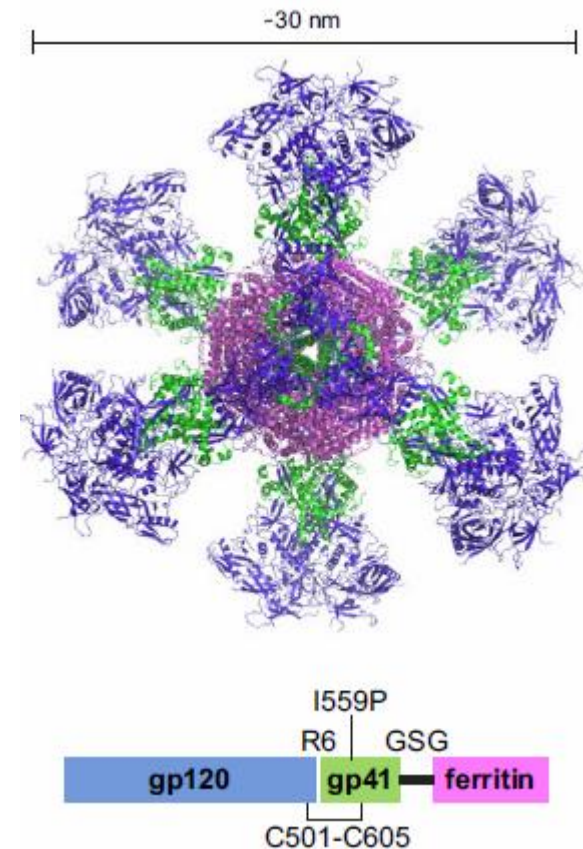
Jesper Glückstad, DTU, Copenhagen

Khalil ISM et al. (2014) Appl Phys Lett **104**, 223701

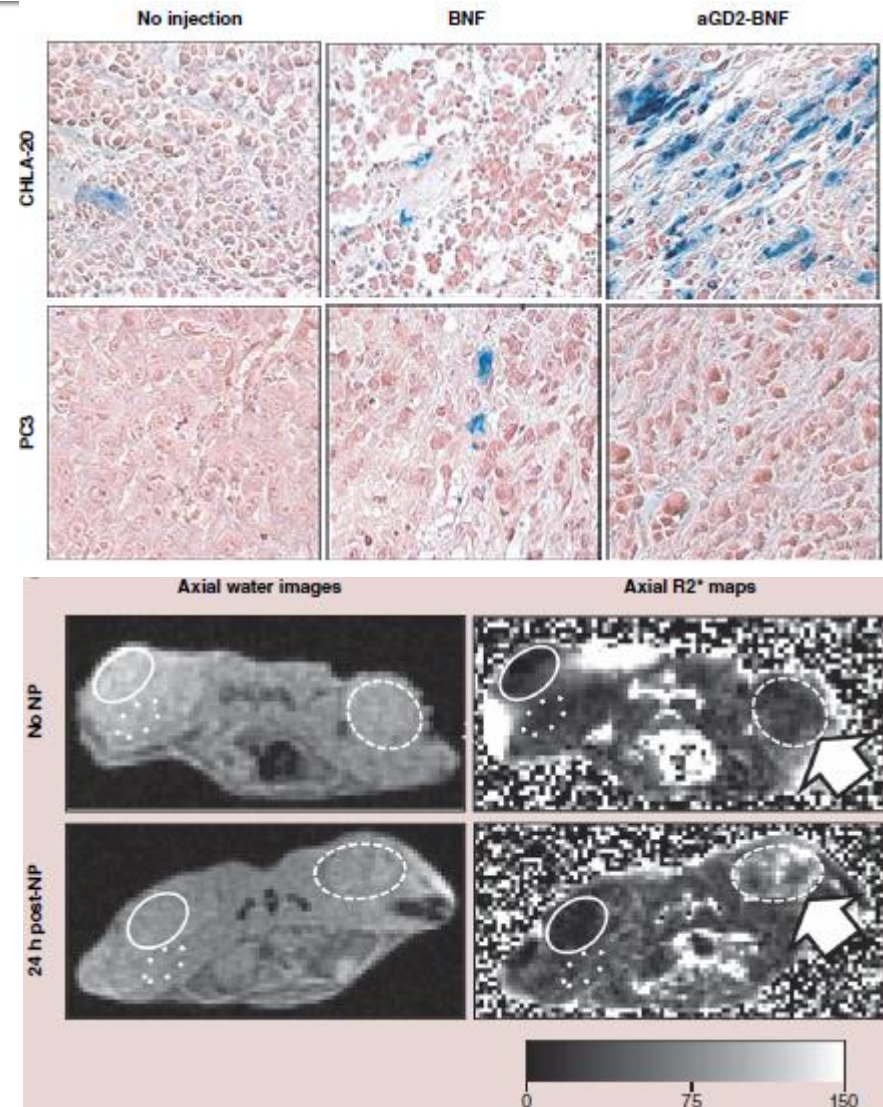
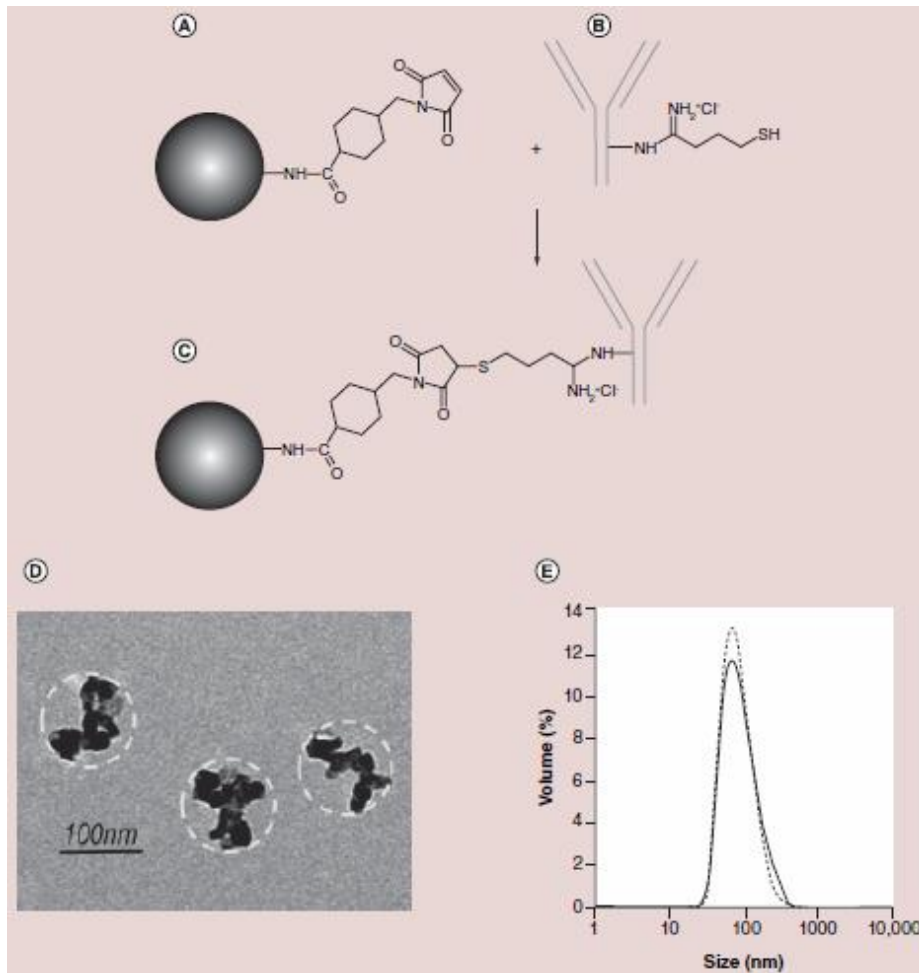


Ferritin Nanoparticles for HIV-1 Vaccination

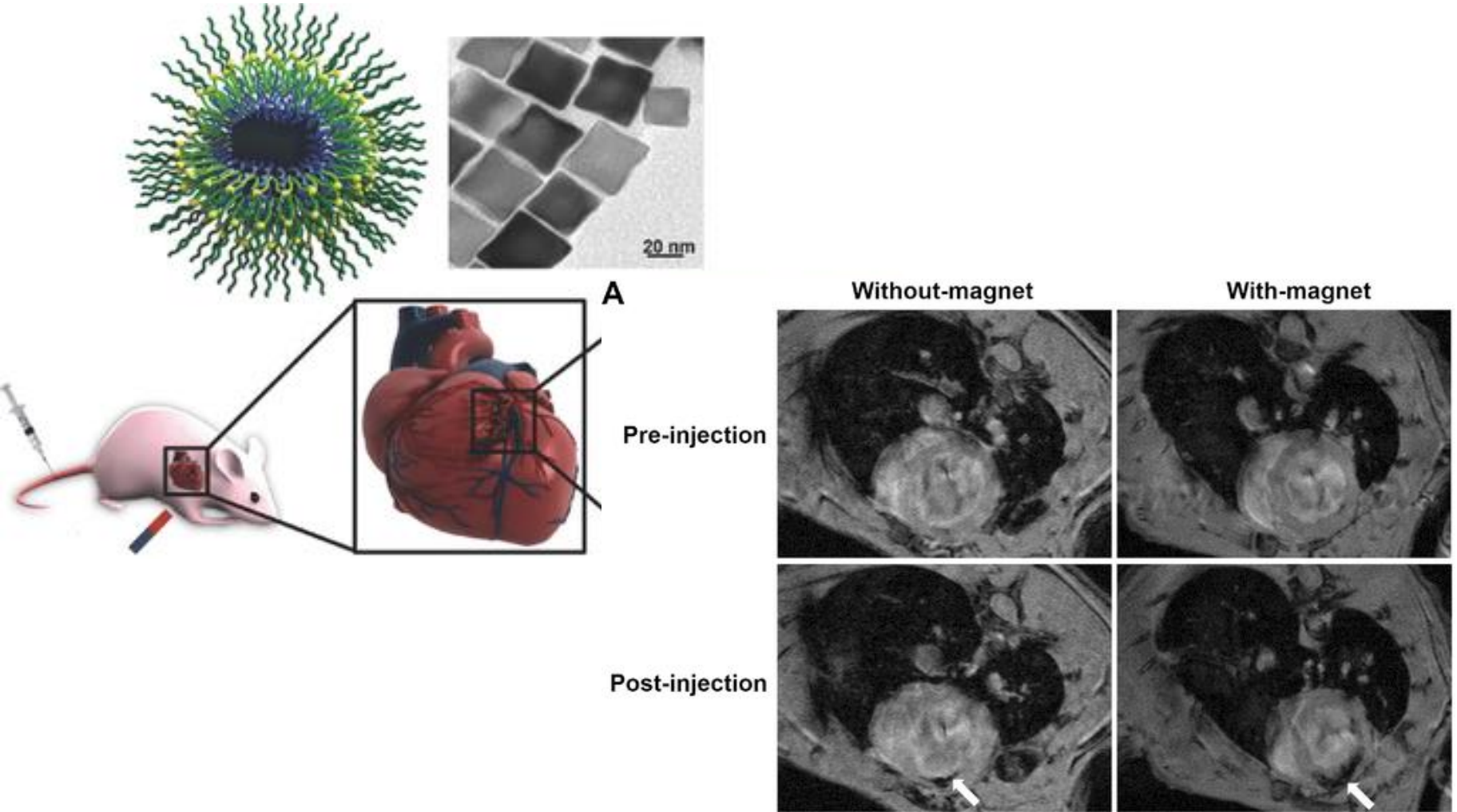
- Enhancement of vaccine antigens' B-cell activation by simply connecting them to (magnetic) nanoparticles
- Worked when applied to HIV-1 envelope glycoprotein trimers



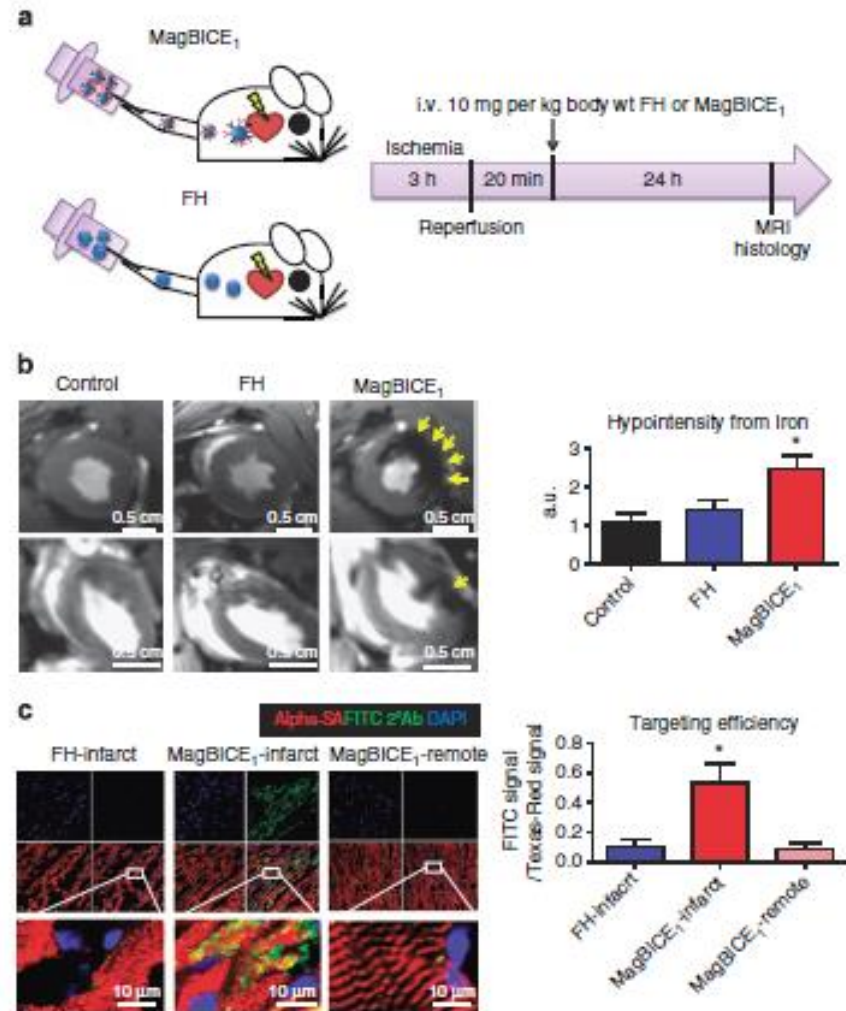
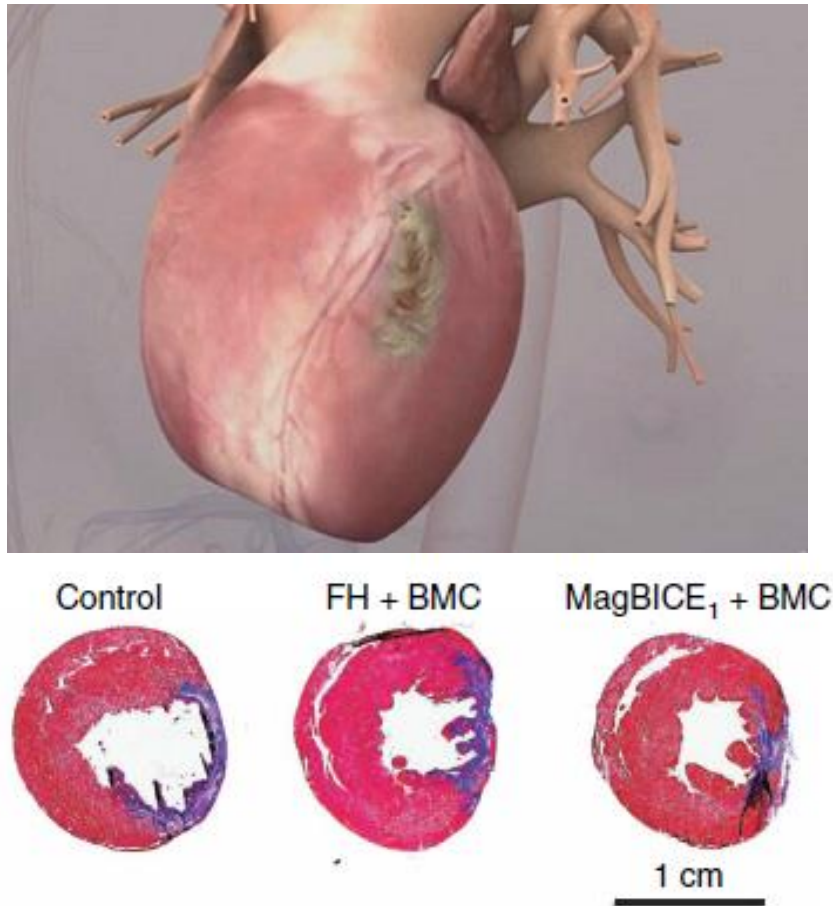
Targeting with Antibody-Coupled MNPs



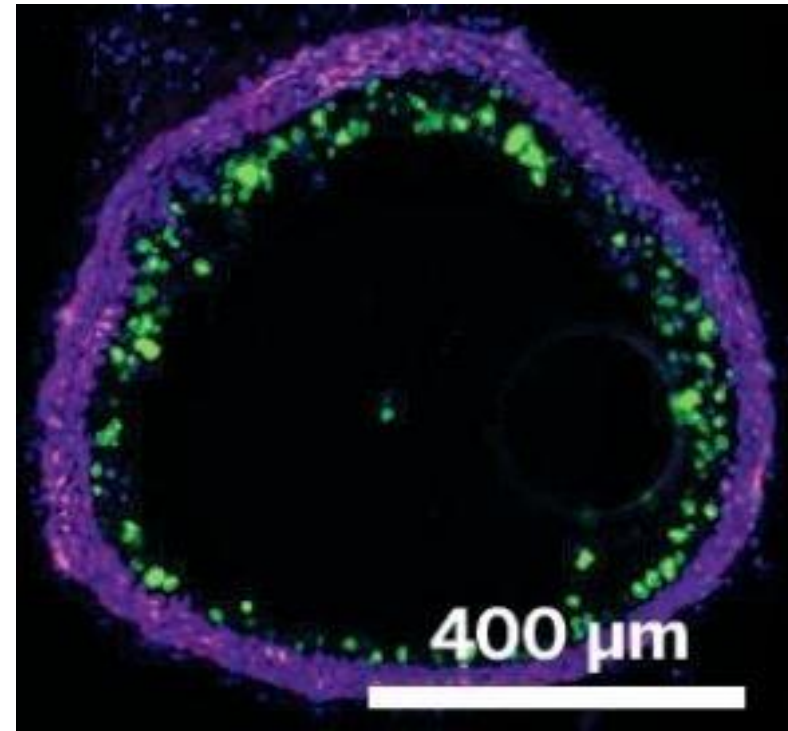
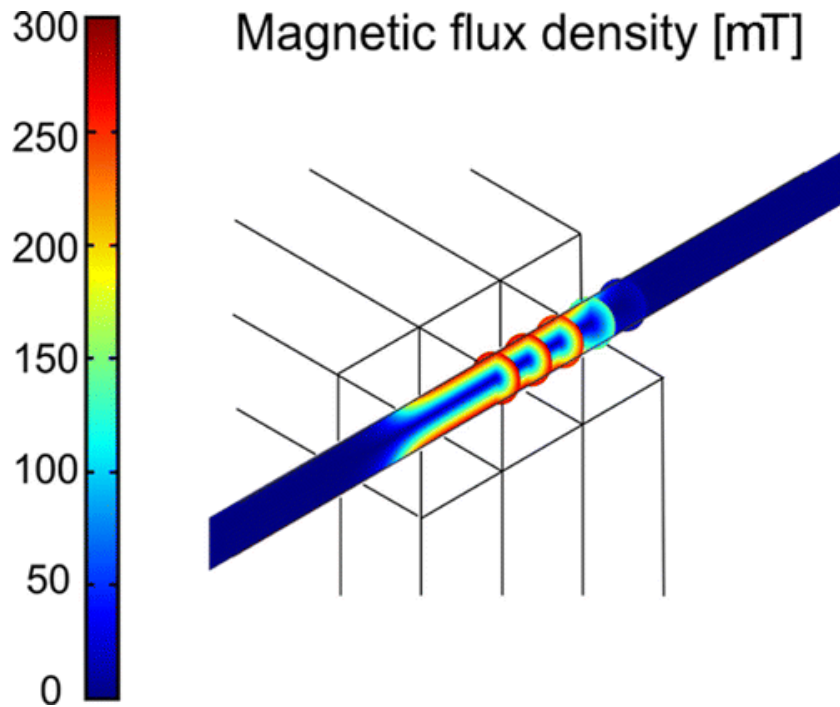
MRI of Myocardial Infarction



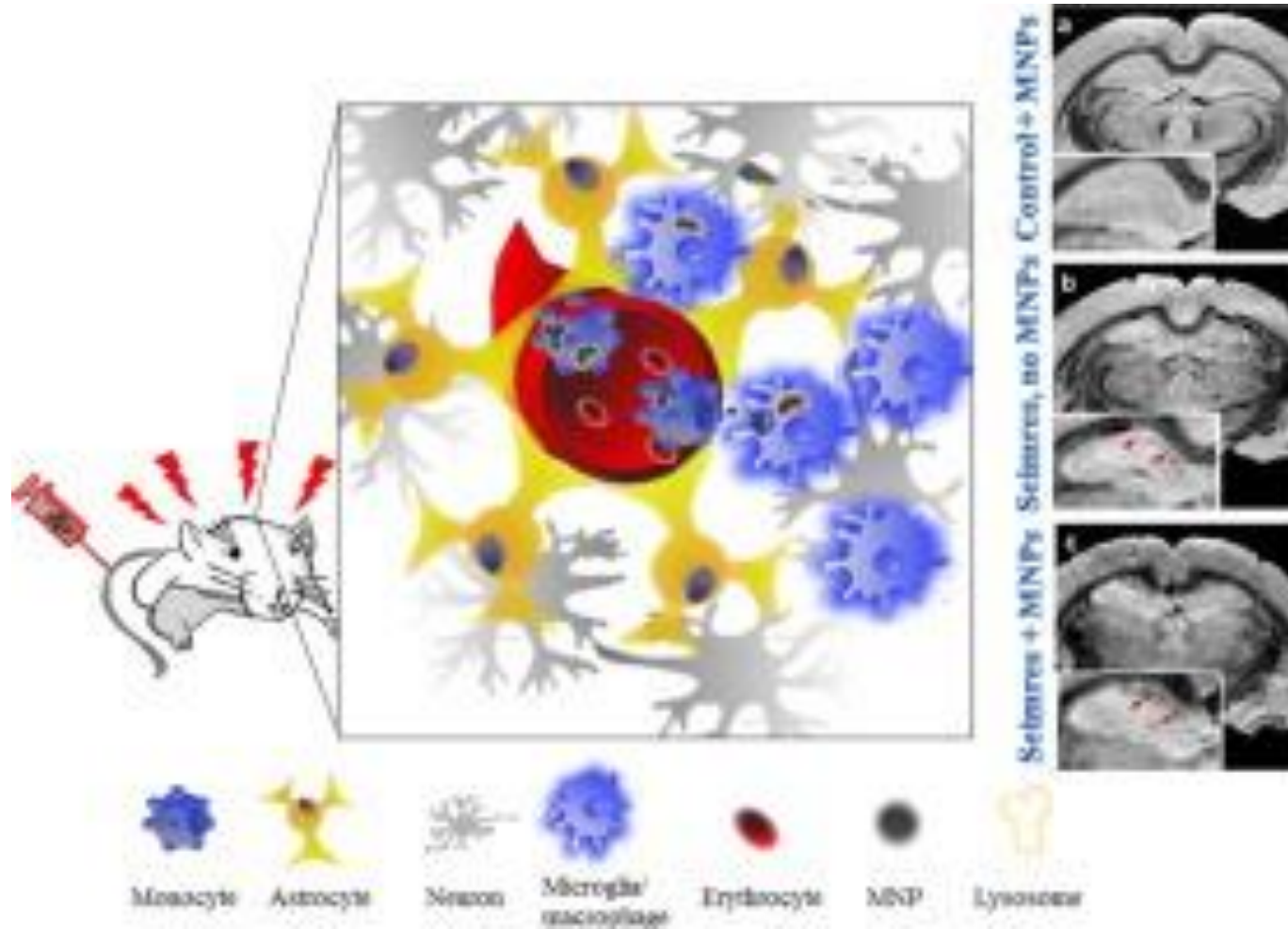
Stemcell Targeting to the Heart



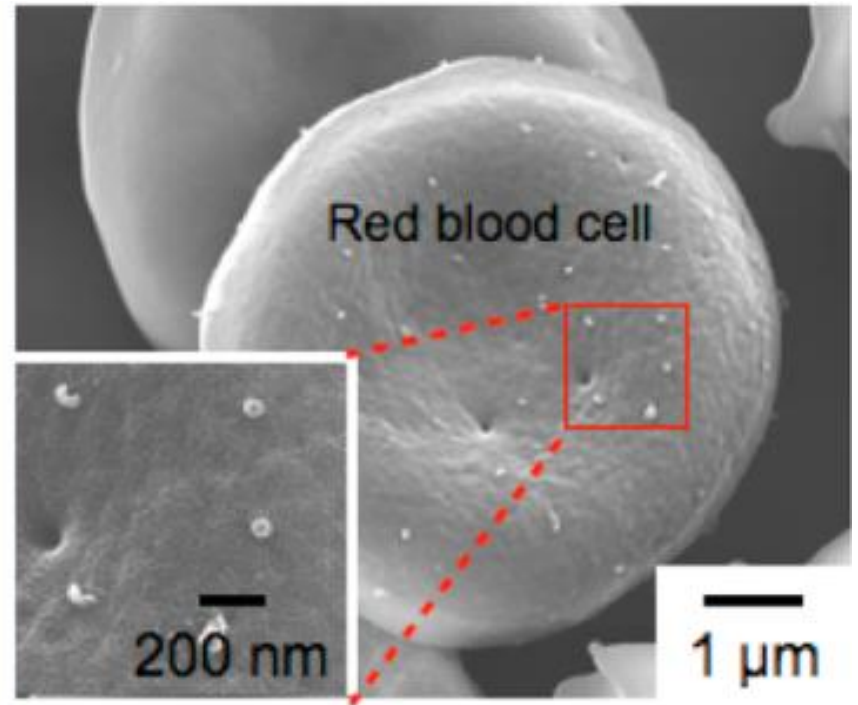
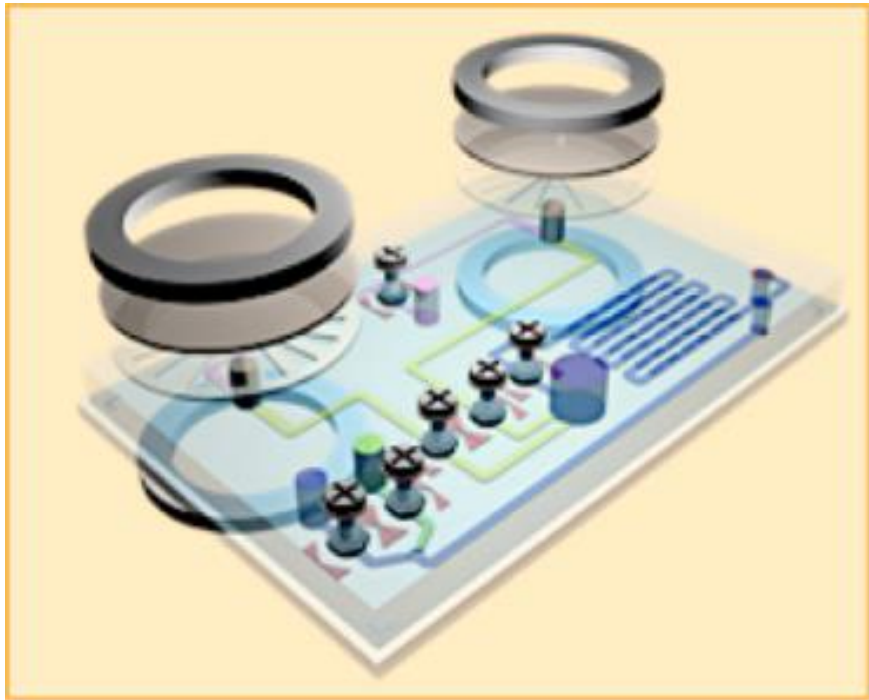
Vascular Repair by Circumferential Cell Therapy With Magnetic Particles



Targeting Epileptic Foci in Brain

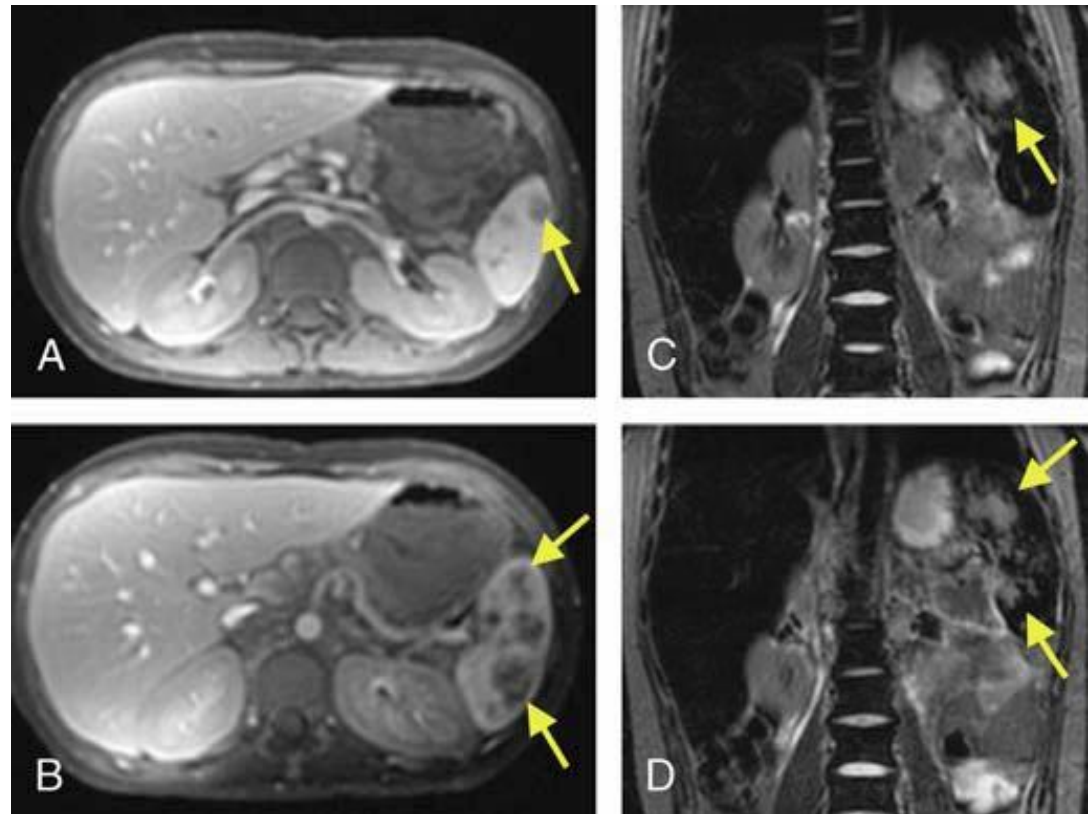


Detection of Erythrocyte Microvesicles



Toxicity of Ferumoxytol USPIOs

- Off-label MRI contrast agent tested in pediatric and young adults



There is Much More



... from your colleagues during the next few days here at the meeting !

And don't forget to check (and contribute) to our website:

<http://www.magneticmicrosphere.com>

Magnetic Bill



Magnetic Attraction



Thank You

- Exhibitors
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 - Travel Grants
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- Participants

