

Report

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SOLARI REPORT "FUTURE SCIENCE"

Ulrike Granögger

Medical Nanobots

Part 1

Implications of the Wave Genome

Credits and Links for Further Study

General

Dictionary on Nanotechnology

www.nanodic.com

Scale of the Universe

<https://htwins.net/scale2/>

Transmission Electron Microscope

Image of cell viewed with TEM:

www.sciencelearn.org.nz/resources/1692-history-of-microscopy-timeline

Diagram of TEM from Wikipedia

https://en.wikipedia.org/wiki/Transmission_electron_microscopy#/media/File:Scheme_TEM_en.svg

Scanning Tunneling Microscopy

Scanning Tunnelling Microscopy: High-Resolution Imaging of Nanoparticle Surface Structures

<https://analyticalscience.wiley.com/do/10.1002/imaging.6397/full/>

Scanning Tunneling Microscope

www.ibm.com/ibm/history/ibm100/us/en/icons/microscope/

Image of Quantum Coral from:

www.nisenet.org/catalog/scientific-image-quantum-coral-top-view

Image of IBM in atoms:

www.cnet.com/news/ibms-35-atoms-and-the-rise-of-nanotech/

IBM *film* made of atoms: "A Boy and His Atom": The World's Smallest Movie

<https://youtu.be/oSCX78-8-q0>

Optical Tweezers

Image: 3D tracking of a macrophage and an optically trapped silica bead

www.osapublishing.org/optica/fulltext.cfm

Super Resolution Fluorescence Microscopy

Direct Observation of Nanoparticles within Cells at Subcellular Levels by Super-Resolution Fluorescence Imaging

<https://www.x-mol.com/paper/5625485>

Two-Photon Polymerization Direct Laser Writing

3D-Printed Nano Structures

<https://interestingengineering.com/3-d-printed-nano-sculptures-will-blow-your-mind>

This Photon-Printed Carbon Is Stronger Than Diamond

<https://youtu.be/0KJjs4W09hQ>

Carbon Nanotubes

Image from: www.hisour.com/carbon-nanotube-42863/

Coating silk with carbon nanotubes yields electronic yarn by the yard

<https://cen.acs.org/materials/biomaterials/Coating-silk-carbon-nanotubes-yields/97/web/2019/10>

Image of carbon nanotube fibres from:

https://commons.wikimedia.org/wiki/File:CSIRO_ScienceImage_1074_Carbon_nanotubes_being_spun_to_form_a_yarn.jpg

A Cell Nanoinjector Based on Carbon Nanotubes

<https://www.pnas.org/content/104/20/8218>

Image of CNT agglomeration from:

www.baua.de/DE/Angebote/Publikationen/Praxis/A94.pdf?__blob=publicationFile&v=7

Teslaphoresis – Nanotube Self-Assembly

Rice University: Teslaphoresis of Carbon Nanotubes

<https://youtu.be/srki1LJVok>

Teslaphoresis of Carbon Nanotubes

<https://pubs.acs.org/doi/10.1021/acsnano.6b02313>

Nanotubes assemble! Rice introduces Teslaphoresis

<https://youtu.be/w1d0Lg6wuvc>

Nanotubes assemble! Rice introduces ‘Teslaphoresis’

<http://news.rice.edu/2016/04/14/nanotubes-assemble-rice-introduces-teslaphoresis-2/>

More on Carbon Nanotubes:

Carbon Nanotubes

<https://youtu.be/eb6tZbxJFS0>

Carbon Nanotubes

<https://youtu.be/H-a2dC9Bgak>

Production from CO₂ capture from the air: Direct Air Capture Technology

<https://carbonengineering.com>

Converting Toxic Industrial Gases into Carbon Nanotubes and Fibers

www.azonano.com/article.aspx?ArticleID=5509

CMOS Scaling, Transistors and IC Evolution:

Semiconductor Timeline

www.computerhistory.org/siliconengine/timeline/

Beyond CMOS computing

https://nanohub.org/resources/18348/download/NikonovBeyondCMOS_1_scaling.pdf

Promising Lithography Techniques for Next-Generation Logic Devices

<https://doi.org/10.1007/s41871-018-0016-9>

Figure 4 from above: Basic NIL process steps

<https://link.springer.com/article/10.1007/s41871-018-0016-9/figures/4>

Carbon Nanotubes to print computer chips:

Video: From Lab to Fab: Pioneers in Nano-Manufacturing

<https://youtu.be/tZeO9I1KEec>

Future Carbon Nanotube Transistors

MIT engineers build advanced microprocessor out of carbon nanotubes

<https://news.mit.edu/2019/carbon-nanotubes-microprocessor-0828>

Company NANOSYS co-founded by Charles M. Lieber

www.nanosysinc.com

Synthetic Biology

Image: Cost per Genome

https://de.m.wikipedia.org/wiki/Datei:Cost_per_Genome.png

Online sales of Human Cell Cultures, example

www.the-odin.com/human-cell-culture/

Genetic Engineering Starter Kit

www.the-odin.com/genetic-design-starter-kit-crispr/

CRISPR-Cas9

CRISPR Nobel Prize

www.sciencemag.org/news/2020/10/crispr-revolutionary-genetic-scissors-honored-chemistry-nobel

Video with Dr. Jennifer Doudna: "CRISPR in Context: The New World of Genetic Engineering" World Science Festival

<https://youtu.be/RNRZchHaKgw>

Additional, recommended video: Distinguished Speaker Series - Jennifer Doudna - "CRISPR and Coronavirus"

<https://youtu.be/MFXhhkv5UKs>

First Person Treated for Sickle Cell Disease with CRISPR Is Doing Well

www.healthline.com/health-news/first-person-treated-for-sickle-cell-disease-with-crispr-is-doing-well

In Vivo CRISPR/Cas9 Gene Editing Corrects Retinal Dystrophy in the S334ter-3 Rat Model of Autosomal Dominant Retinitis Pigmentosa

<https://pubmed.ncbi.nlm.nih.gov/26666451/>

First Patient Receives In Vivo CRISPR Editing

www.the-scientist.com/news-opinion/first-patient-receives-in-vivo-crispr-editing-67222

Video: How Scientists Used CRISPR to Edit Human DNA In Vivo

<https://edhub.ama-assn.org/jn-learning/video-player/18468298>

Example company: CRISPR Therapeutics

www.crisprtx.com

APPLICATIONS

Nanoparticle Drug Delivery

Engineering precision nanoparticles for drug delivery

www.nature.com/articles/s41573-020-0090-8

Drug Delivery Nanoparticles Given Neurotransmitter “Passports” to Cross Blood-Brain Barrier

www.genengnews.com/news/drug-delivery-nanoparticles-given-neurotransmitter-passports-to-cross-blood-brain-barrier/

Nano-Biosensors

Profusa Oxygen Platform / Biogel-Sensors

<https://profusa.com/our-vision/>

Profusa and Partners Announce Initiation of Study to Measure Early Signs of Influenza Through Biosensor Technology

www.prnewswire.com/news-releases/profusa-and-partners-announce-initiation-of-study-to-measure-early-signs-of-influenza-through-biosensor-technology-301014961.html

A Military-Funded Biosensor Could Be the Future of Pandemic Detection

www.defenseone.com/technology/2020/03/military-funded-biosensor-could-be-future-pandemic-detection/163497/

Video 60 Minutes: A sensor that can tell you if you're sick,

<https://youtu.be/No5Bz2eHNtA>

Example company producing nano-inks:

<https://xtpl.com/applications/biosensors/>

Overview: Nanobiosensors: applications in biomedical technology

<https://iopscience.iop.org/article/10.1088/1757-899X/805/1/012028/pdf>

Nanopropellers

Nanopropellers and their actuation in complex viscoelastic media

<https://pubmed.ncbi.nlm.nih.gov/24911046/>

Video: Helical Micro and Nanopropellers for Applications in Biological Fluidic Environments

<https://vimeo.com/131750857>

More videos:

<https://vimeo.com/user19894571>

Nanoswimmers

Self-assembly of robotic micro- and nanoswimmers using magnetic nanoparticles

<https://link.springer.com/article/10.1007/s11051-014-2737-z>

Video: Multiple robot control of 3 bead achiral microswimmers

<https://youtu.be/cKr-rTXxHRU>

Nanorobots

Electronically integrated, mass-manufactured, microscopic robots

www.nature.com/articles/s41586-020-2626-9

Walking Microrobots Cornell University Itai Cohen. Plus *video:*

www.nature.com/articles/d41586-020-02486-z

Microgrippers, Theragrippers

Untethered Single Cell Grippers for Active Biopsy

<https://pubs.acs.org/doi/10.1021/acs.nanolett.0c01729>

Video: Microgripper captures single cells for tissue biopsy

<https://youtu.be/NbypK8u4HZs>

Gastrointestinal-resident, shape-changing microdevices extend drug release in vivo

<https://advances.sciencemag.org/content/6/44/eabb4133>

Tetherless thermobiochemically actuated microgrippers

www.pnas.org/content/106/3/703

Johns Hopkins researchers take inspiration from parasitic work for medicine delivery

<https://hub.jhu.edu/2020/11/25/theragripper-gi-tract-medicine-delivery/>

Nanorollers

Bioinspired micro-robot based on white blood cells

<https://techxplore.com/news/2020-05-bioinspired-micro-robot-based-white-blood.html>

Nanoworms

Yuri Gunko - Magnetic nanoworms and nanowires for nanomedicine

<https://youtu.be/FH0WugcS36Y>

More and general on Nanobots

List of research

<https://www.sciencedirect.com/topics/engineering/nanobots>

Video: World Science Festival: Cellular Surgeons: The New Era of Nanomedicine

<https://youtu.be/FzFY5ms3AUc>

Magnetic Control of Nanoparticles

Researchers achieve remote control of hormone release

<https://news.mit.edu/2020/remote-control-hormone-release-nanoparticles-0410>

A new way to deliver drugs with pinpoint targeting

<https://news.mit.edu/2019/lipid-magnet-deliver-drugs-0819>

Genetically targeted magnetic control of the nervous system

www.nature.com/articles/nn.4265

Maneuverability of Magnetic Nanomotors Inside Living Cells

<https://onlinelibrary.wiley.com/doi/epdf/10.1002/adma.201800429>

Magnetothermal genetic deep brain stimulation of motor behaviors in awake, freely moving mice

<https://elifesciences.org/articles/27069>

Application of Magnetic Nanoparticles in Pharmaceutical Sciences

www.ncbi.nlm.nih.gov/pmc/articles/PMC3040350/

Superparamagnetic iron oxide nanoparticles: magnetic nanoplatforms as drug carriers

<https://pubmed.ncbi.nlm.nih.gov/22848170/>

Superparamagnetic nanoparticle delivery of DNA vaccine

<https://pubmed.ncbi.nlm.nih.gov/24715289/>

Magnetogenetics

Genetically engineered 'Magneto' protein remotely controls brain and behaviour

www.theguardian.com/science/neurophilosophy/2016/mar/24/magneto-remotely-controls-brain-and-behaviour

Is magnetogenetics the new optogenetics?

www.embopress.org/doi/full/10.15252/emj.201797177

Magnetothermal genetic deep brain stimulation of motor behaviors in awake, freely moving mice

<https://elifesciences.org/articles/27069>

Brain Machine Interfaces

Mesh Electronics, Charles M. Lieber Lab

Lieber Research Group at Harvard

<http://cml.harvard.edu>

Bioinspired neuron-like electronics

www.nature.com/articles/s41563-019-0292-9

Electronic stealth neurons offer enhanced brain studies and treatments

www.nibib.nih.gov/news-events/newsroom/electronic-stealth-neurons-offer-enhanced-brain-studies-and-treatments

Precision electronic medicine in the brain

www.nature.com/articles/s41587-019-0234-8

Syringe Injectable Electronics: Precise Targeted Delivery with Quantitative Input/Output Connectivity

http://cml.harvard.edu/assets/NanoLett_2015_15_6979-6984_Hong.pdf

Scalable ultrasmall three-dimensional nanowire transistor probes for intracellular recording

www.nature.com/articles/s41565-019-0478-y

A method for single-neuron chronic recording from the retina in awake mice

<https://science.sciencemag.org/content/360/6396/1447>

Video: Syringe-injectable Mesh Electronics

www.jove.com/de/v/58003/syringe-injectable-mesh-electronics-for-stable-chronic-rodent

Syringe-injectable mesh electronics integrate seamlessly with minimal chronic immune response in the brain

<https://www.semanticscholar.org/paper/Syringe-injectable-mesh-electronics-integrate-with-Zhou-Hong/32b9c6f9254a9311f61faf3ec3563f22b125c043>

Nanowire Nanosensors for Highly Sensitive and Selective Detection of Biological and Chemical Species

<https://science.sciencemag.org/content/293/5533/1289.abstract>

The future of mind control

<https://medicalxpress.com/news/2019-09-future-mind.html>

Why did a Chinese university hire Charles Lieber to do battery research?

www.sciencemag.org/news/2020/02/why-did-chinese-university-hire-charles-lieber-do-battery-research

Carbon Nanotubes and the Bill Gates / Charles Lieber Connection

<https://youtu.be/g7u1VzS-VjE>

Smart Dust / Neural Dust

“Smart Dust” Biosensors powered by biomolecular motors

<https://pubs.rsc.org/en/content/articlelanding/2009/LC/b821055a#!divAbstract>

Tiny implant could connect humans and machines like never before

www.independent.co.uk/news/science/neural-dust-implant-sensor-brain-nerve-humans-machines-prosthetics-berkeley-a7170251.html

Wireless Recording in the Peripheral Nervous System with Ultrasonic Neural Dust

[www.cell.com/neuron/fulltext/S0896-6273\(16\)30344-0](http://www.cell.com/neuron/fulltext/S0896-6273(16)30344-0)

Neural Dust: An Ultrasonic, Low Power Solution for Chronic Brain-Machine Interfaces

<https://arxiv.org/pdf/1307.2196v1.pdf>

Galvani Bioelectronics

<https://galvani.bio>

Biological Transistors / Biocomputers

Amplifying Genetic Logic Gates

<https://science.sciencemag.org/content/340/6132/599>

A CRISPR/Cas9-based central processing unit to program complex logic computation in human cells

www.pnas.org/content/116/15/7214

Stanford creates biological transistors, the final step towards computers inside living cells

<https://ethz.ch/en/news-and-events/eth-news/news/2019/04/biosynthetic-dual-core-cell-computer.html>

A biosynthetic dual-core cell computer

<https://www.extremetech.com/extreme/152074-stanford-creates-biological-transistors-the-final-step-towards-computers-inside-living-cells>

Biological transistor enables computing within living cells

<https://engineering.stanford.edu/magazine/article/biological-transistor-enables-computing-within-living-cells>

Stanford Bioengineers Introduce ‘Bi-Fi’ — The Biological Internet

<https://engineering.stanford.edu/magazine/article/stanford-bioengineers-introduce-bi-fi-biological-internet>

Engineered cell-cell communication via DNA messaging

<https://jbioleng.biomedcentral.com/articles/10.1186/1754-1611-6-16>

Book on Storing Digital Binary Data in Cellular DNA

www.sciencedirect.com/book/9780323852227/storing-digital-binary-data-in-cellular-dna#book-info

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