

Nanotech Application in Life Sciences; Nanomedicine in the Basel Area

Introduction

The Basel region has the potential of becoming one of the world's leading areas in nanomedicine. Basel namely has a cluster of life science and nanotechnology research, development and commercial use which is fairly unique in the world, both in number and size of organisations as in the quality of research.

This overview on the potential of nanomedicine in Basel has been made to draw a global picture of what Switzerland and especially the region of Basel has to offer with respect to life sciences-nanotechnology-nanomedicine. Naturally more information could be provided or visits and meetings facilitated for interested UK research institutes.

Background

Nanomedicine is the application of nanotechnology in medicine with the aim of developing drug delivery, diagnostic and therapeutic tools. The region Basel has the potential of becoming one of the world's leading areas in nanomedicine for two reasons.

On the one hand Basel houses a life science cluster with biotechnology, pharmaceuticals, medical technology and speciality chemicals. Through the mix of multinationals, SME's, universities and research institutes research ranges from basic to applied research and commercial use of products.

Furthermore the Basel region is Switzerland's most important area for nanotechnologies; also internationally it belongs to one of the most attractive locations for activities in this technology area. This is once again thanks to the large number of companies and research institutes active involved in nanotechnology. Again basic research is conducted, but there is also commercial use of nanotechnologies, especially in the area of chemicals.

With nanotechnology the Basel area will have a second important future technology next to life sciences. Only in Silicon Valley and in the Boston area these two clusters can be found together.

This combination of a high number of key life science companies (Clariant, Ciba, Syngenta, Roche, Novartis, DSM, Lonza, Huntsmann) and research institutes on the one hand and key nanotechnology research centres (like University of Basel, Swiss Nanoscience Institute) creates an enormous potential for synergies and collaboration between these technology areas.

In this overview you will find a list of companies, technology networks and research institutes engaged in nanomedicine. The majority are based in or around Basel.

COMPANIES

Chemical and pharmaceutical companies in the Basel area are active in the full range of nanotechnology: research, product development or product optimisation. Furthermore several companies are engaged in the development of special equipment

Pharmaceutical industry in Basel makes use of nanotechnology in detection, drug discovery and drug delivery:

- **Actelion:** Drug discovery programme, characterise biological targets and their interaction with compounds in development
- **Novartis:** Development of biodegradable nano-scale drug delivery systems, which are broken down in the human body and/or within the environment. As preliminary risk assessments indicate a potential negative impact of certain non-biodegradable nano-materials, e.g. carbon nanotubes, on consumer, occupation and environmental health, they currently do not consider engagements in such areas.
- **Pharmida:** Subsidiary of Midatech (Oxford UK): nanoparticle drug development program
- **Roche & Swiss Nanoscience Institute:** have developed an innovative method for the rapid and sensitive detection of disease- and treatment-relevant genes using nanomechanical sensors.
- **Zeptosens:** conducts ultrasensitive biomolecular analysis based on nanotechnology-based microarrays and readout systems

Advance materials and product coatings:

- **DSM:** nanomaterials research
- **Ciba Specialty Chemicals:** delivery and distribution of active ingredients such as vitamins and skin conditioners
- **Clariant:** nanoceramics, with multiple applications in space, conductors, electronics etc
- **Huntsman:** application of supramolecular chemistry: materials providing toughness while being lightweight. Applications in pharmaceutical therapies, drug delivery and disruption of protein-protein interactions that are important to cellular functions.
- **Institut Straumann:** applications in dental implants
- **Syngenta:** applications in crop protection and seed treatment products

Development of special equipment such as specialised microscopes or analytical equipment:

- **Concentris:** analytical instruments and sensors
- **Nanoscan:** high resolution scanning probe microscopes
- **Nanosurf:** Atomic force microscopes and scanning tunnelling microscopes

NANOTECHNOLOGY NETWORKS

- The National Center of Competence in Research, NCCR Nanoscale Science is a network involving several universities, federal research institutes and industrial partners, like EMPA materials science, the Paul Scherrer Institute for natural and engineering sciences and the Federal Institute for Technology in Zürich, ETHZ. The leading house is the Swiss Nanoscience Institute based at the University of Basel. www.nccr-nano.org
More information about focus areas here below under *research institutes*.
- i-net Basel brings together suppliers, customers and research organisations to encourage demand-driven joint innovation and to accelerate developments through cooperation between research bodies and industry. I-Net Basel focuses on fields of technology that promise to create sustainable added value for the future of Basel. One of the 3 fields of technology is Nanotechnology, however without specifically focussing on nanomedicine. www.inet-basel.ch
- European Foundation for Clinical Nanomedicine: interaction and information flow between clinicians, researchers, public and other stakeholders. Plans to open a European Research Lab Space for Clinical Nanomedicine in Basel. www.clinam.org

The European Foundation for Clinical Nanomedicine plans to realise its project of the International Translational Laboratory for Nanomedicine (INTRALAB-N) in Basel, Switzerland. Basel is the location of many chemical and pharmaceutical companies. The town offers excellent scientific facilities with the Department of Research of the Basel University Hospital, the University of Basel with its Biozentrum and private research places such as the Friedrich Miescher Institute. Basel is worldwide renowned for its Swiss Nanoscience Institute (SNI) developed from the National Center of Competence in Research (NCCR) for Nanoscale Science. The project shall be in joint cooperation with five Universities in Europe.

MAIN RESEARCH INSTITUTES AND DEPARTMENTS IN NANOMEDICINE

Research group Nanomedicine, University hospital Basel <http://www.swissnano.org/>

Main contacts: Dr. Patrick Hunziker HunzikerP@uhbs.ch
Dr. Pavel Broz BrozP@uhbs.ch

The group, which is part of the NCCR Nanoscale Science at the University of Basel, focuses on three research projects:

1. Polymer nanocontainers for receptor-specific cell targeting
<http://www.swissnano.org/Nanocontainer%20targeting.html>

The nanocontainer projects focus on specific targeting of cells or receptors to prevent the undesirable side effects of drugs. It furthermore opens opportunities for delivering therapeutic genes to specific cellular targets within body.

The project explores the potential of synthetic, functional nanocontainers as generic, versatile carriers by examining their interaction with a clinically important receptor-specific cell model.

Functionalized nanocontainers for targeted delivery to active macrophages are a very promising example that combines the ideas of nanomedicine – bottom-up fabrication, miniaturization, complex functionality and targeted delivery to a specific site.

2. Polymer nanocontainers as intelligent nanometer-sized bioreactors

<http://www.swissnano.org/Nanocontainer%20reactor.html>

The group investigates the use of nanocontainers) made of amphiphilic triblock (hydrophilic-hydrophobic-hydrophilic) copolymer building blocks for targeted delivery of drugs or contrast agents in humans. In aqueous solution, the used polymers form unilamellar vesicles with specific diameters, allowing the encapsulation of water-soluble substances such as drugs, enzymes, nucleotides, radioisotopes, or contrast media into the self-assembled nanostructures.

The goal of this subproject is the development of intelligent sensor-effector reactivity within polymer nanocontainers. This would enable a controlled activation or release of encapsulated content inside the target cell or would even allow the creation of nanometer-sized simple bioreactors for target-specific therapeutic applications in medicine.

3. Microfluidic networks for diagnostic applications in medicine in collaboration with IBM Zürich.

<http://www.swissnano.org/Microfluidic%20networks%20project.html>

The activities in microfluidics address the design, fabrication, and use of simple microfluidic networks for the simultaneous delivery of functionally distinct molecules onto targeted regions of a surface.

Swiss Nanoscience Institute, University Basel

<http://www.nanoscience.ch/nccr/>

The Swiss Nanoscience Institute (SNI) developed from the National Center of Competence in Research (NCCR) “Nanoscale Science” and constitutes a priority program of the University of Basel. It is worldwide recognized as a centre of excellence for nanoscale sciences. It combines basic science with application-orientated research. The University of Basel as the leading house coordinates the NCCR network of the involved universities, federal research institutes, industrial partners and the Argovia-network, which is financed by the Swiss Canton of Aargau.

The various project teams are interdisciplinary groups made up of physicists, pharmacologists, biologists, chemists, physicians, computer scientists and engineers. Many of them work at the University of Basel, but some also work at partner institutions within the network.

The research groups with application in medical areas are:

Nanobiology http://www.nanoscience.ch/nccr/research/module_01

Self-assembly at surfaces http://www.nanoscience.ch/nccr/research/module_05

Two concrete projects with nanoscale technology and applications in medical areas are:

- **D2GEL** **Wolfgang Meier** **University of Basel**
In the D2Gel project the efficient blocking of the release of the contents of artificial vesicles in a gel matrix could be shown. This is an important step for developing a “smart” drug release concept from vesicles in gels.
- **Nano-PerSPECT** **Roger Schibli,** **Paul Scherrer Institute**
The Nano-PERSPECT project aims for improved tumor imaging using labelled peptide

nanoparticles. This topic has been covered by several nano Argovia projects in the past and steady progress can be reported on this quite complex matter.

Other research groups are

- Quantum Computing and Quantum Coherence
- Atomic and Molecular Nanosystems
- Molecular Electronics
- Applied Projects in Nanoscience and Nanotechnology
- Nanoethics

Nanoscale Materials Science at EMPA, Swiss Institute of Materials Science

http://www.empa.ch/plugin/template/empa/941/*/--/l=1

“Nanoscale Materials Science” addresses scientific questions and technological problems in surface science and -technology, magnetism, nanoscience and –technology. The interest ranges from the study of atomic and molecular nanosystems by means of advanced scanning probe microscopy, the fabrication of hard coatings, coatings for medical applications, magnetic thin films and devices, magnetic shape memory alloys, to surface analysis services by TOF-SIMS, XPS and scanning Auger. The section is organized in five research groups and has a strong link to the NCCR on Nanoscale Science at the University of Basel, Switzerland, and SwissProbe AG.

The research group focuses on Surface Technology: medical applications with Diamond Like Carbon, DLC http://www.empa.ch/plugin/template/empa/*/33371

Current research projects are:

- Modified DLC to control the cell proliferation
- DLC-V for toxic bioreactions
- Nanomaterials for high efficiency and low cost
- Characterization of wound pads
- Coatings and surfaces for cell movement
- A nano-electrode for intracellular potential measurements
- DLC in biological applications
- DLC in hip joints
- Tribological moisture sensitivity of diamond-like carbon films

The other research groups are:

- Forces, Surfaces and Magnetism http://www.empa.ch/plugin/template/empa/991/*/--/l=1
- Nanostructural Coatings http://www.empa.ch/plugin/template/empa/992/*/--/l=1
- Molecular Surface Science http://www.empa.ch/plugin/template/empa/993/*/--/l=1
- Organic Surface Technology http://www.empa.ch/plugin/template/empa/995/*/--/l=1

IBM Research labs Zürich, research group “Experimental Biosciences”

<http://www.zurich.ibm.com/st/bioscience/experimental.html>

In the [Experimental biosciences](#) project, IBM employs addresses important problems in medicine and biology by using their expertise in in micro/nanotechnology, surface chemistry and biochemistry

and working together with experts in life sciences. The project is done in collaboration with the research group Nanomedicine of the University of Basel.

The focus is on:

- (1) developing novel miniaturized biosensing platforms and
- (2) applying them to important problems in biology.

The main techniques employed are based on:

- "[Biopatterning](http://www.zurich.ibm.com/st/bioscience/biopatt.html)," where proteins are patterned with very high accuracy onto surfaces to serve as receptors for analytes, <http://www.zurich.ibm.com/st/bioscience/biopatt.html>
- And "[Microfluidics](http://www.zurich.ibm.com/st/bioscience/microfluidics.html)," where minute volumes of liquid are utilized or analyzed. <http://www.zurich.ibm.com/st/bioscience/microfluidics.html>

The current challenges deal with:

- the detection of protein analytes from low volumes of sample with high sensitivity (**micromosaic immunoassays**)
<http://www.zurich.ibm.com/st/bioscience/assays.html>
- the rapid detection of disease markers in an accurate manner (**chips for life**)
http://www.zurich.ibm.com/st/bioscience/poc_testing.html
- the investigation of inter cellular pathways that are relevant to diseases of the brain (**brain chip**)
<http://www.zurich.ibm.com/st/bioscience/brainchip.html>
- the identification and addressing of specific cells on surfaces for diagnostic and research applications (**microfluidic probe**).
<http://www.zurich.ibm.com/st/bioscience/probe.html>

The Friedrich Miescher Institute for Biomedical Research <http://www.fmi.ch/>

Scientists at the FMI pursue basic biomedical research, making use of

- genetic approaches in model organisms
- detailed proteomic and genomic analyses
- quantitative and live fluorescence imaging
- structure determination

in their studies of [cell growth control](#), [epigenetics](#) and [neurobiology](#).

As part of the **Novartis Research Foundation**, the FMI is situated at the interface of academic research and biomedical application. Through collaborative efforts with Novartis, FMI scientists also contribute to the development of both diagnostics and medicines.

An example of nanomedicine application is trials to restore light sensitivity to blind retinas through artificial photoreceptors.

Biozentrum at the University Basel www.biozentrum.unibas.ch

The Biozentrum is a department of the University of Basel. It is an interdisciplinary institute dedicated to basic molecular and biomedical research. At the Biozentrum, approximately 35 research groups (with researchers from more than 30 nations) investigate biological processes on a molecular basis. The spectrum of their work ranges from basic questions (What does a cell consist

of, and how does it work?) to the development of whole organisms (How does a cell know whether to become a leg or an eye?)

The individual research groups are centred on three theme-oriented “Focal Areas” :

- Growth & Development,
- Infection Biology,
- Neurobiology

plus two technology-oriented “Core Programs”:

- Computational & Systems Biology
- Structural Biology & Biophysics

Research Group Wolfgang Meier, Department of Chemistry, University Basel

<http://www.chemie.unibas.ch/~meier/>

On Nanoscale objects, polymer membranes, nanocontainers

Radiological Physics department of University Hospital Basel

http://pages.unibas.ch/dmr/mr_physik/

Imaging

Acute Coronary Syndrome research, Medical Intensive Care Unit, University Hospital Basel

<http://pim.uhbs.ch/MIPS/VulnerableNano.htm>

Nanotechnological applications in Arteriosclerosis, detection and treatment of vulnerable plaques, by use of microscopic small tests based on microfluidics (also in collaboration with IBM Research lab Zürich)

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