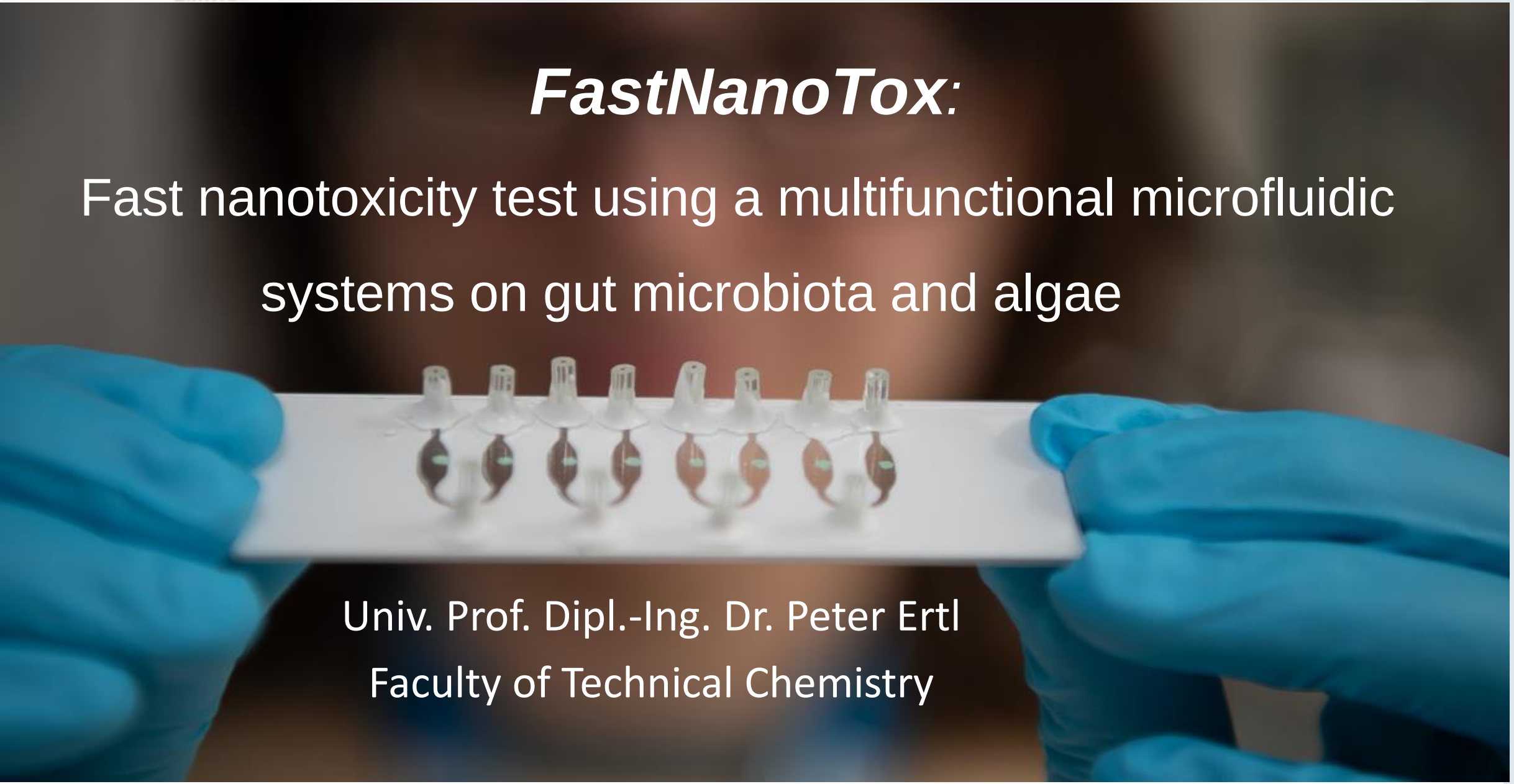
FastNanoTox:

Fast nanotoxicity test using a multifunctional microfluidic systems on gut microbiota and algae

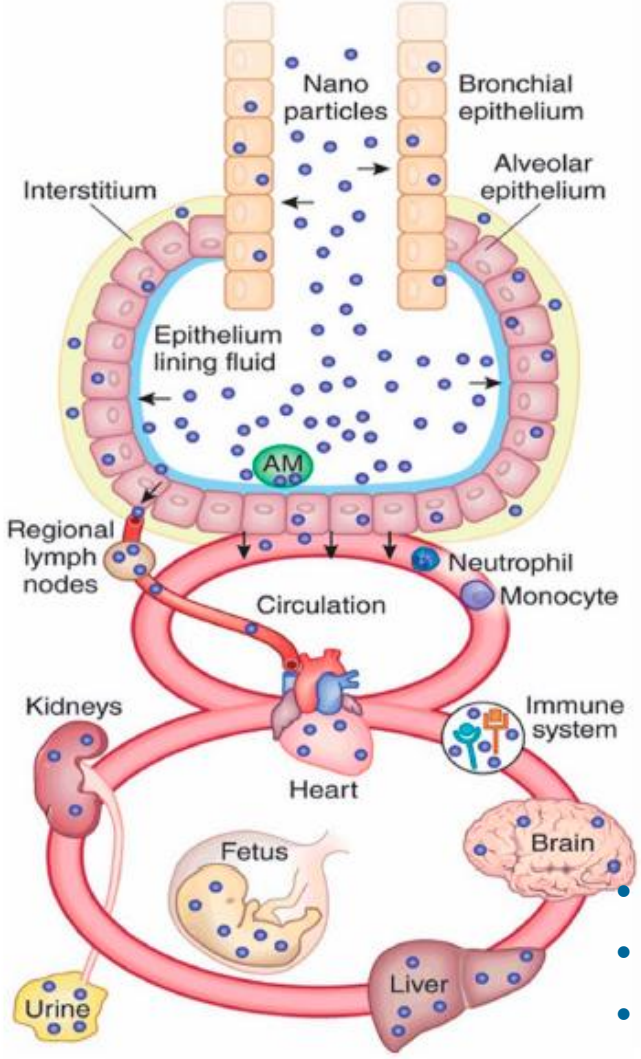


Univ. Prof. Dipl.-Ing. Dr. Peter Ertl

Faculty of Technical Chemistry

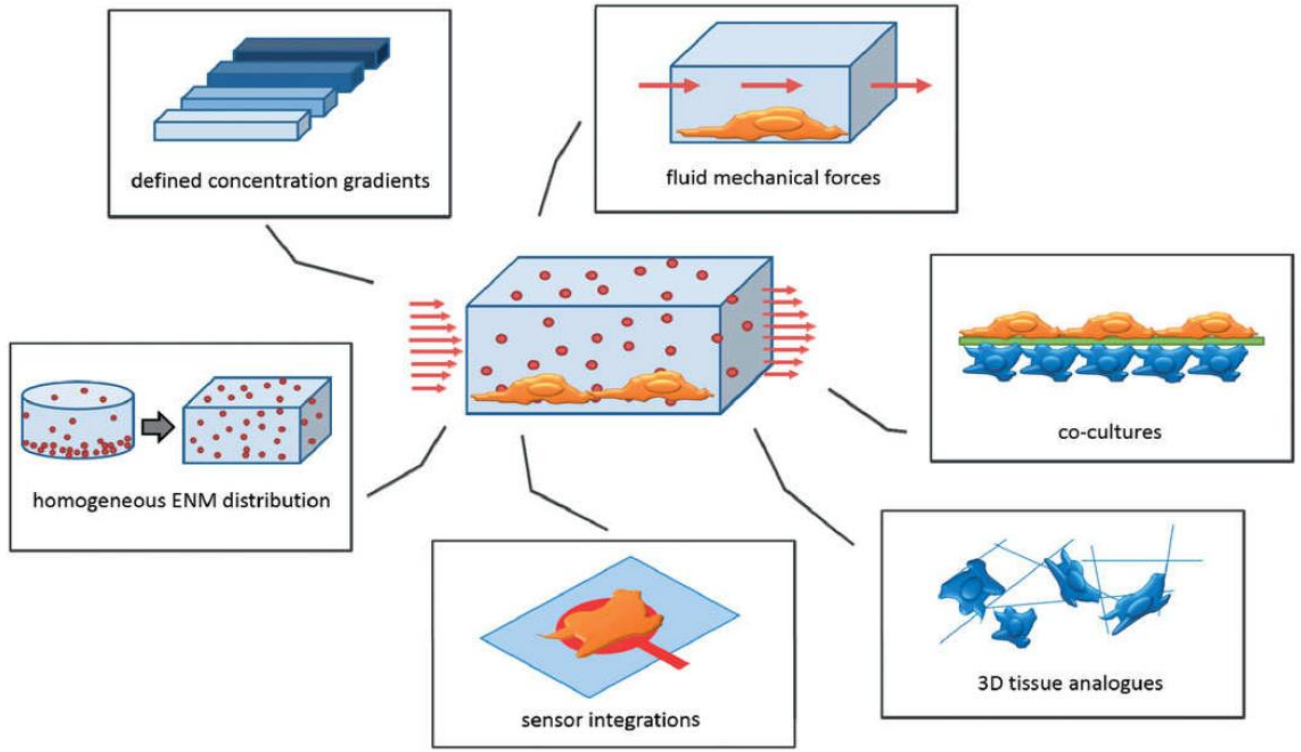
Toxic effects of engineered NP

Nanotoxicology



Kreyling et al, Nat. Biotechnol, 2010.

Benefits of chip-based Nanotox



Mahto et al, Biomicrofluidics, 2010.

- Lung main entry route for 1-100 nm
- Rapid translocation and distribition
- Can enter cell membranes
- Pose risk to viability of cells

What about the microbiome?

Project innovation potentials

Technological goal

TECHNISCHE UNIVERSITÄT WIEN

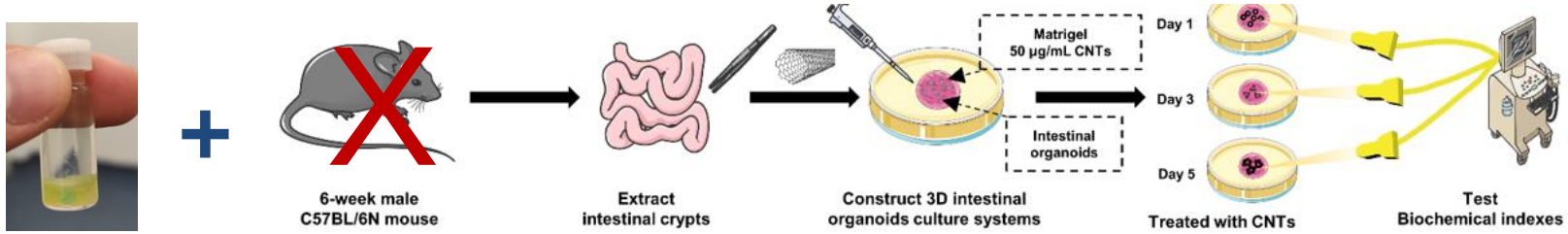
TU Graz

kdg

microfluidics *biosensing* *manufacturability*

The combination of 3D **bioprinting** of algae biofilms and gut bacteria with **inkjet printing** of optical sensors inside a single **microfluidic** device for cost effect and rapid nanotoxicity screening.

Scientific goal

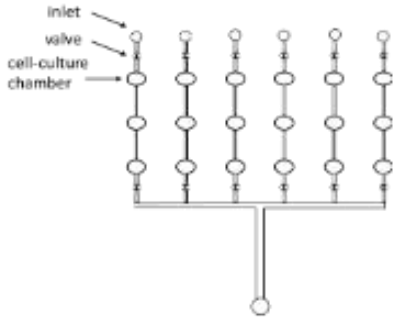


RRR

The project aim to obtain a fundamental understanding of the toxic effects of engineered nanomaterials on the intestinal flora and aquatic organisms.

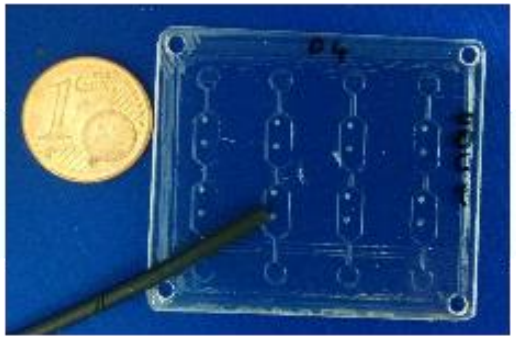
Funding: FFG Project # 849791 and # 869173

From study design to mass production

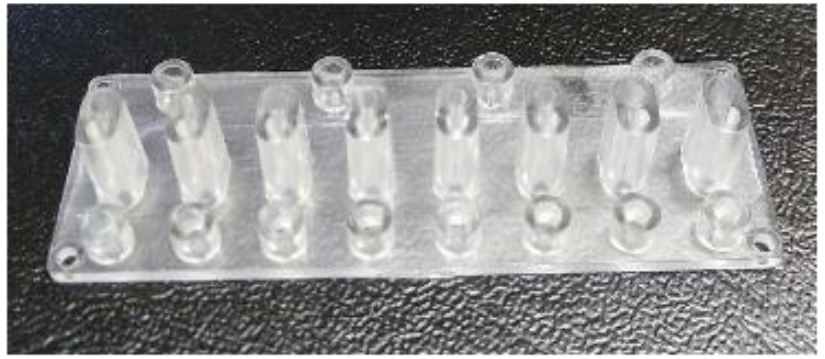


1. Design Study

2. Rapid protoyping



3. Poof-of-concept



4. Final chip

Müller, B.;. *Sensors and Actuators B: Chemical* **2021**, *334*, 129664. https://doi.org/10.1016/j.snb.2021.129664.

Funding: FFG Project # 849791 and # 869173

Sensor integrated industrial prototype

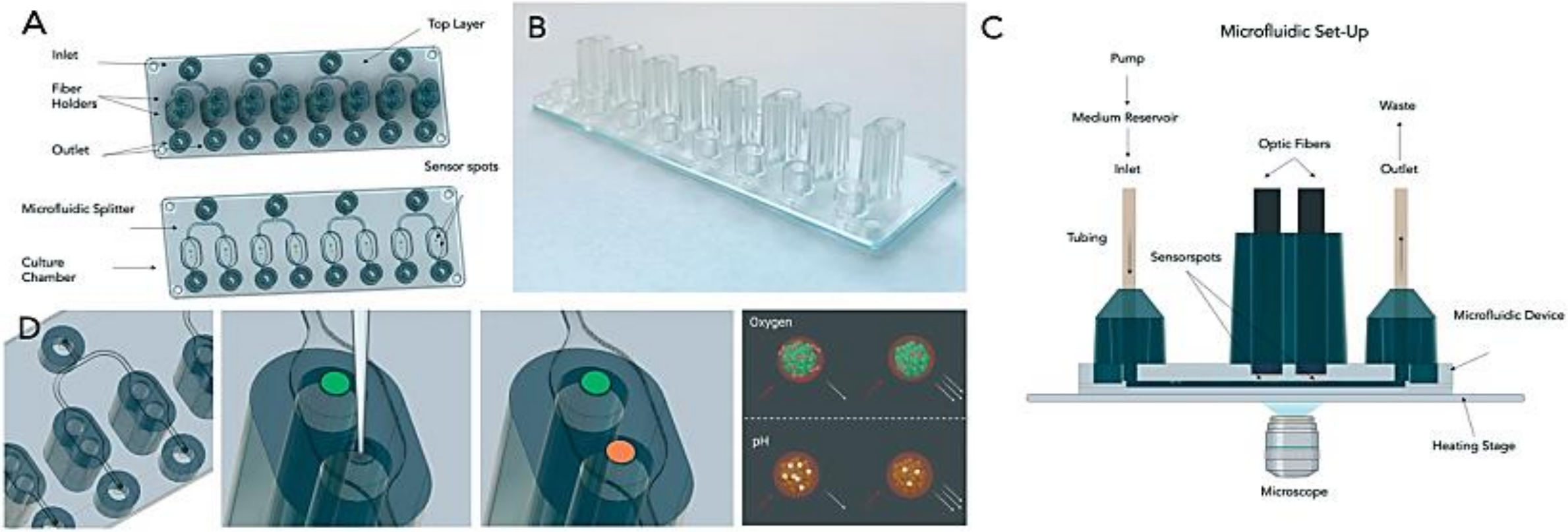
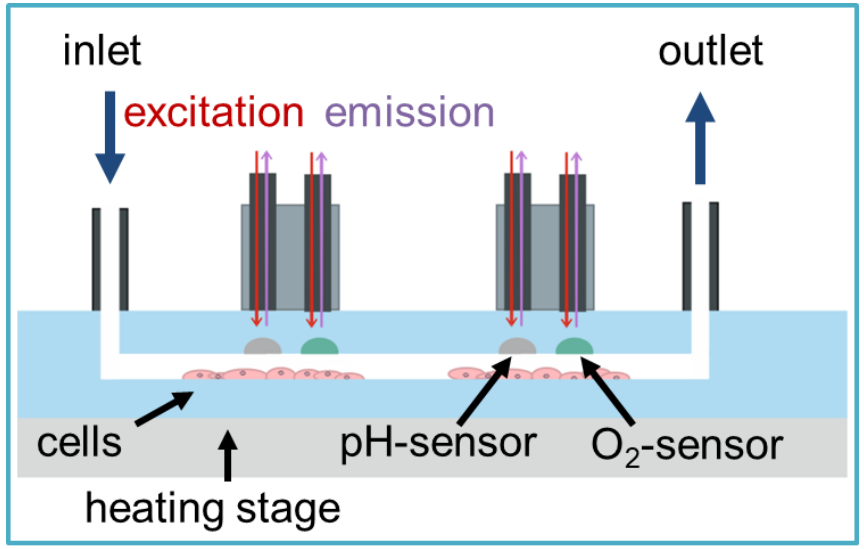


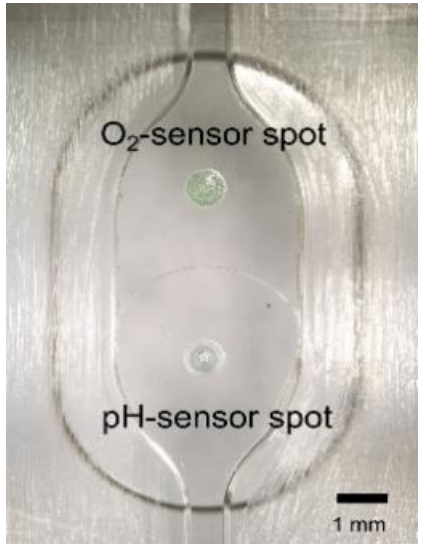
Figure: *Industrial prototype of the microfluidic chip with integrated sensors*. **A**) 3D CAD designs of 8-chamber chip, including inlets, fluidic splitter, culture chambers, and outlets. **B**) Photograph of the manufactured biochip. **C**) Overview of the microfluidic set-up. **D**) Illustrating the sensor integration process of the luminescent sensor spots into the top part of the microfluidic device and sensing working principle.

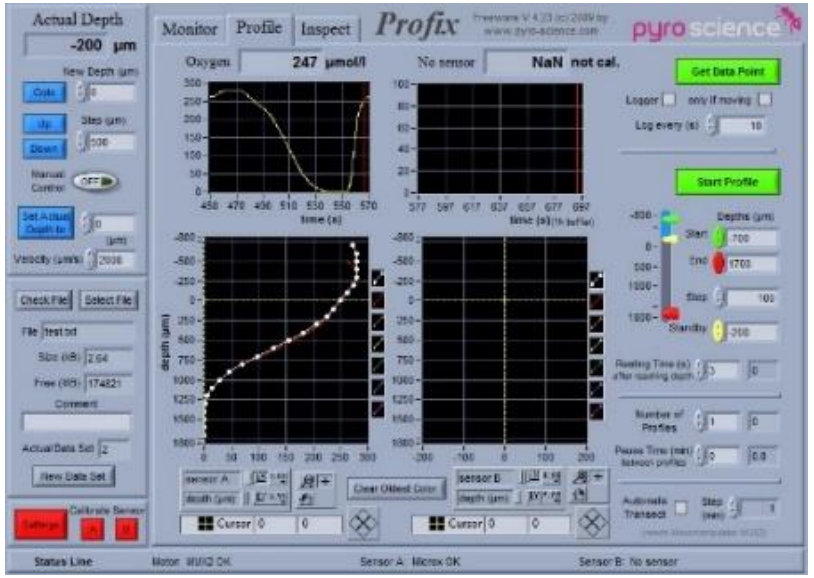
Funding: FFG Project # 849791 and # 869173

Systems periphery

Microfluidic chip with integrated sensors







Light emitted from the FireSting oxygen/pH meter is guided through the optical fibers and excites the oxygen and pH sensors spots located on the upper part of the chamber. The sensor spots generate oxygen and pH concentration-dependent light signals (emission), which are guided back through the optical fibers and detected by the oxygen/pH meter.

Funding: FFG Project # 849791 and # 869173

Our biosensing approach

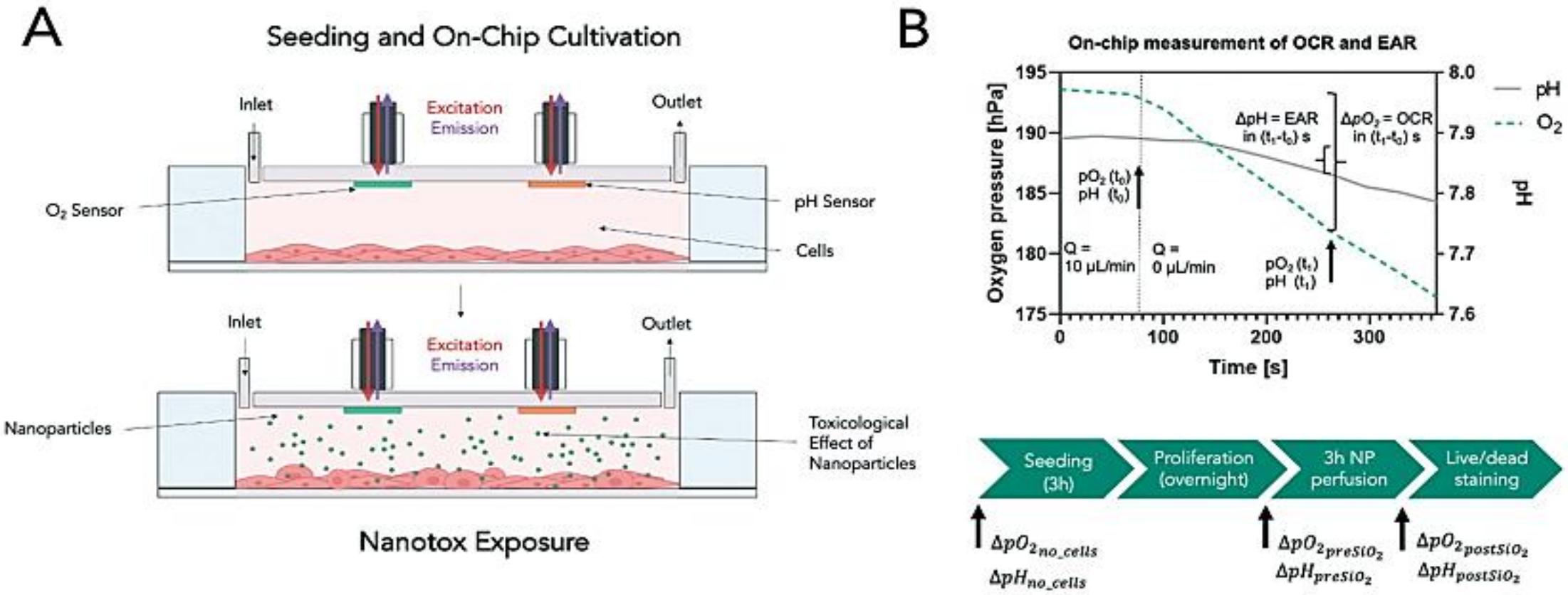


Figure: *Set-up and working principle of microfluidic nanotoxicological assessment and on-chip luminescence-based oxygen and pH sensing*. **A**) Schematic of microfluidic nanotoxicological assessment. **B**) **Stop-flow measurements** to detect the decrease in oxygen pressure and pH within few minutes.

Funding: FFG Project # 849791 and # 869173

Sensing biofilm activity

3-(3,4-Dichlorphenyl)-1,1-dimethylharnstoff

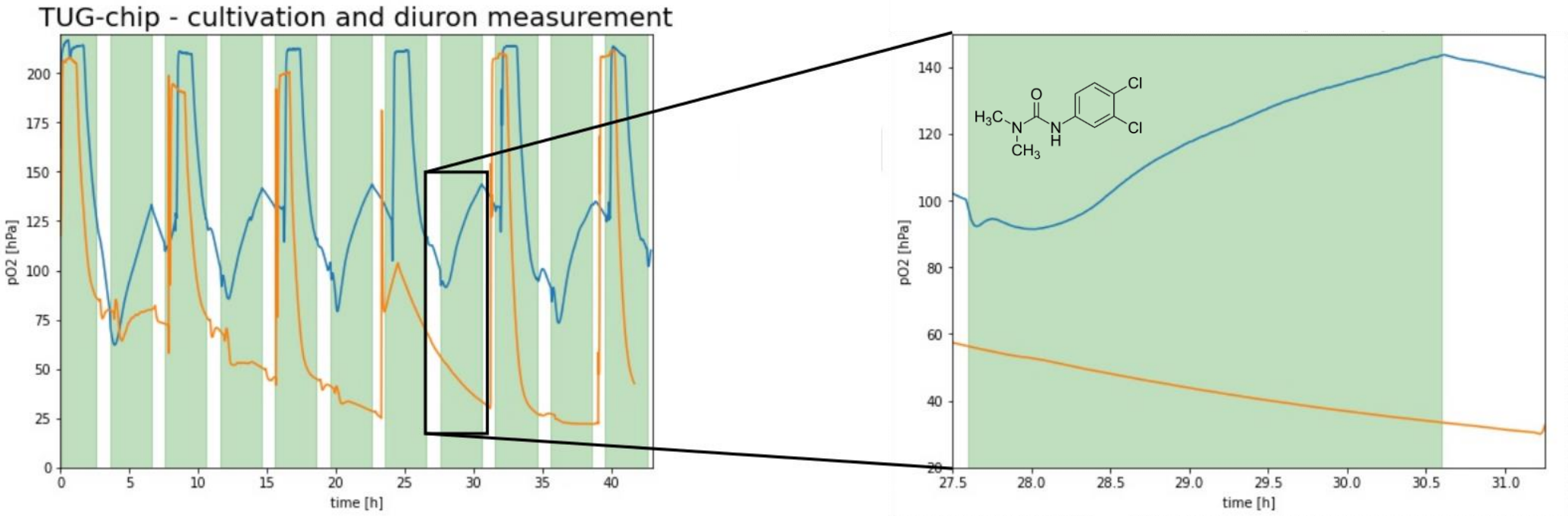
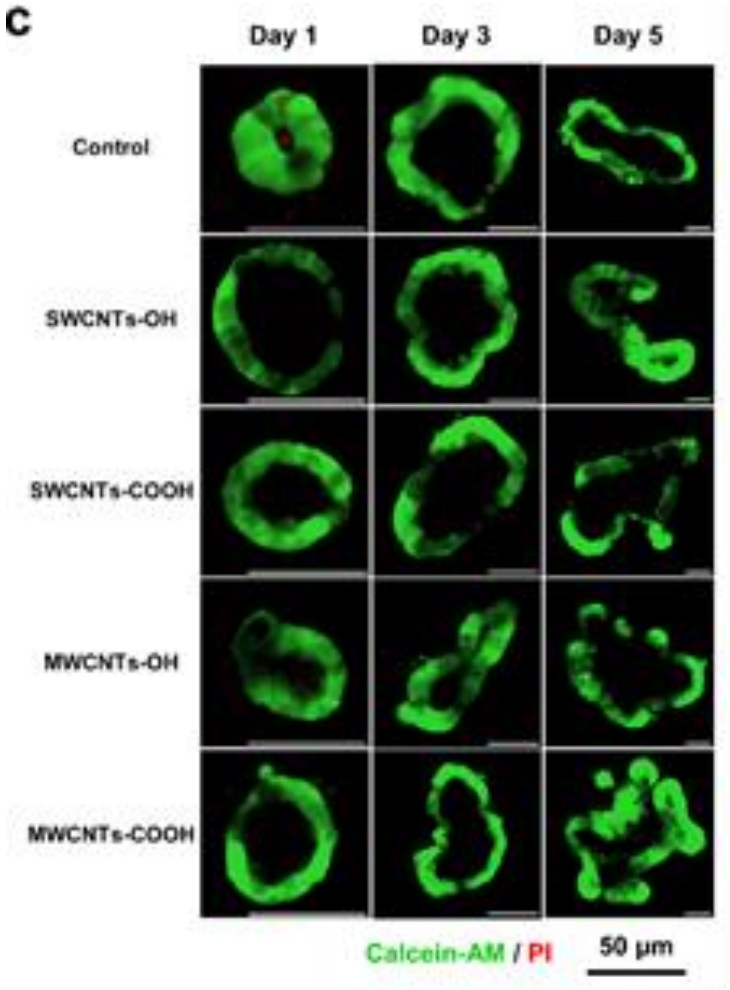


Figure: Oxygen measurement during the cultivation process and diuron treatment (herbicide) of Chlorella Sorokiniana in the algae-chip and zoom on a light/dark cycle.

Funding: FFG Project # 849791 and # 869173

Impact of NP on intestinal lining layer

CNTs are considered to have carcinogenicity and can cause lung tumors.



Silica NP a versatile tool for the treatment of bacterial infections?

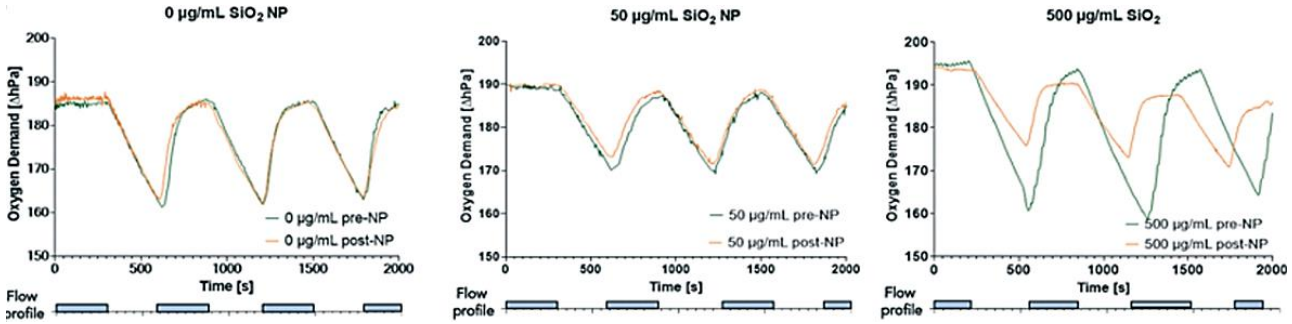


Figure: Oxygen consumption of CaCo-2 cells with increasing nanoparticle concentration in 3 different chambers.

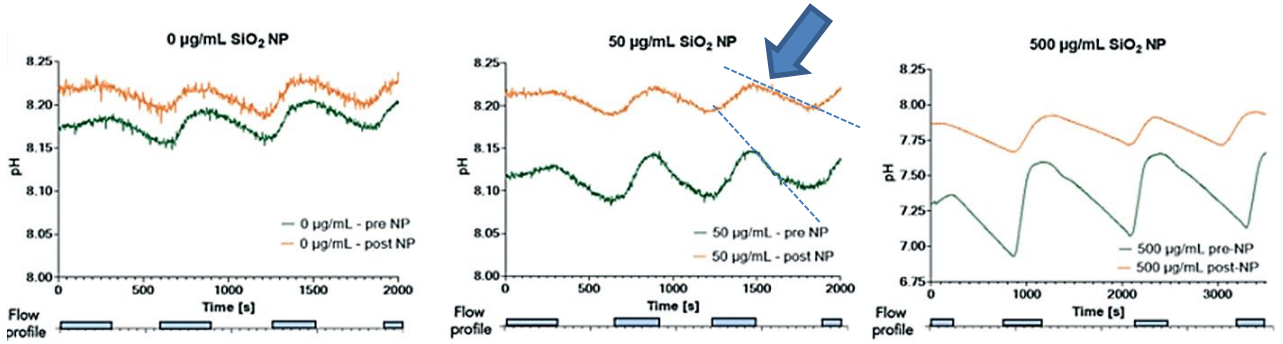
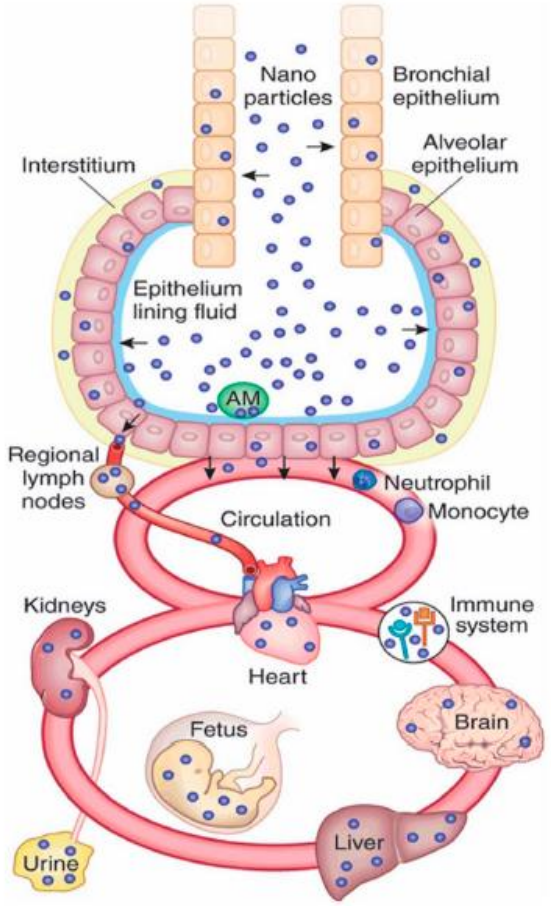
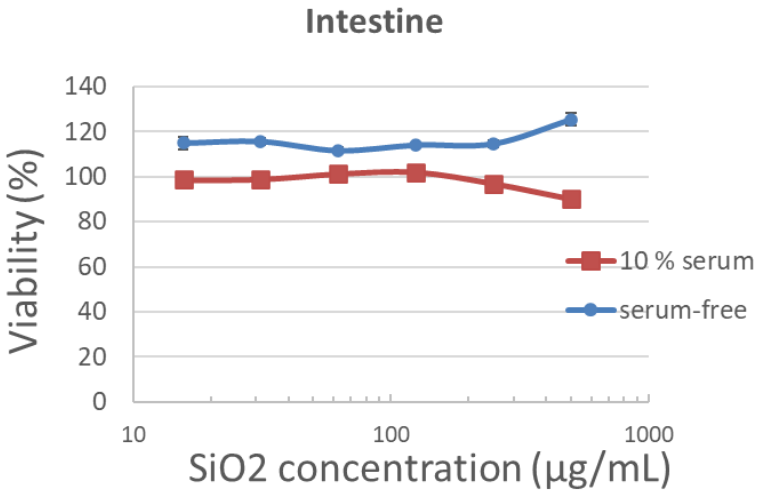


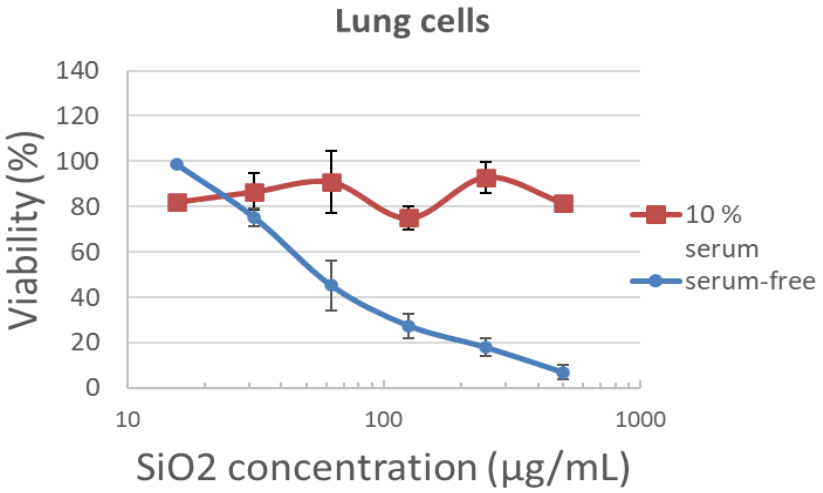
Figure: Extracellular acidification of CaCo-2 cells with increasing nanoparticle concentration in 3 different chambers.

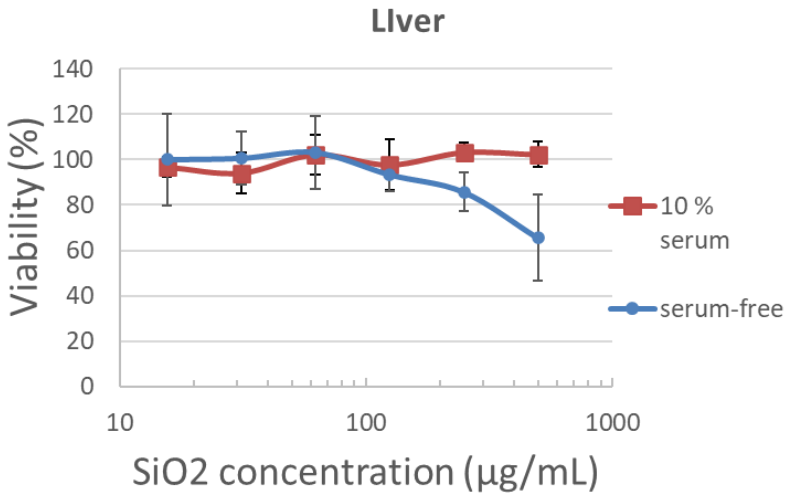
Funding: FFG Project # 849791 and # 869173

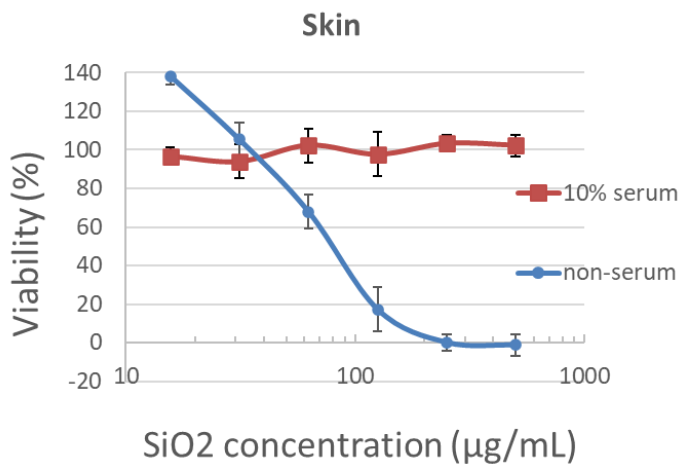
Toxicity of SiO_2 in different cells











Role of BNN in FastNanoTox

BNN contact: Andreas FALK

Role of BNN / BNN contribution:

- supported the initiation of the AT-China-funding scheme (2013-onwards) → next call (9th), expected early 2023 (ICT).
- BNN - not involved as beneficiary
- identified and procured partners

www.tugraz.at/institute/acfc/research/chemical-sensor-and-biosensors/projects/fastnanotox