Nano-Ecotoxicology

Are nanoparticles harmful to aquatic organisms?

General background

Nanomaterials (nanoparticles) are 1-100 nm large materials (particles) which have extraordinary physicochemical properties. Nanomaterials can be found in a variety of products we use every day. They are, for example, used as antibacterial agents in children's toys and textiles, as functional ingredients (e.g., as colorant) in food, as UV-filters in cosmetics and sunscreens, as biocides in anti-fouling paints (e.g., for boats and house facades), and as pesticides in agriculture. Many of these nanomaterials enter the sewage system (e.g., they are released during cloth washing, are washed off the body during showering, or are egested with the urine/feces). However, often they cannot be removed by current wastewater treatment technologies and consequently are discharged into the aquatic environment. Many **nanomaterials are** also directly **released into streams, lakes and the ocean** (e.g., due to sunscreens being washed off the body during swimming, due to weathering /disintegration of anti-fouling paints, or due to agricultural runoff). The production, use and release of nanomaterials into the environment is expected to further increase. Therefore, **exposure of aquatic organisms to nanomaterials is inevitable**. This gives rise to **concern**, as many nanomaterials (nanoparticles) are probably **able to surpass biological barriers** (e.g., gill and gastrointestinal epithelia, blood brain barrier). Furthermore, nanomaterials have a high surface reactivity, which increases the **risk of harmful interactions with biological macromolecules** (e.g., proteins, enzymes, lipids). Moreover, many nanomaterials have a high adsorptive capacity, that is, they **may adsorb and carry other pollutants into the organism (Trojan horse-effect)**. However, today, **we still have very limited knowledge on the toxicodynamics and toxicokinetics of nanomaterials in aquatic organisms**. Therefore, more research is urgently needed.

Our research

With our research, **we aim at filling important gaps of knowledge** related with

- **Molecular and cellular mechanisms of nanoparticle toxicity**
- **Bioaccumulation of nanoparticles**
- **Fate and effect of nanoparticles in aquatic food webs (trophic transfer)**
- **Mixture toxicity effects of nanoparticles and organic chemical pollutants**

The increased understanding of how specific properties of nanomaterials are linked to their toxicity **will help us to better manage the environmental risk associated with nanomaterials** currently used in products and **develop nanomaterials which are safe-by-design**.

Your project

At present, we have **several large research projects addressing highly topical research questions in nano-ecotoxicology** and **we look forward to welcome interested and highly motivated students** to carry out their degree project (Bachelor or Master's thesis) within this **novel and exciting field**.

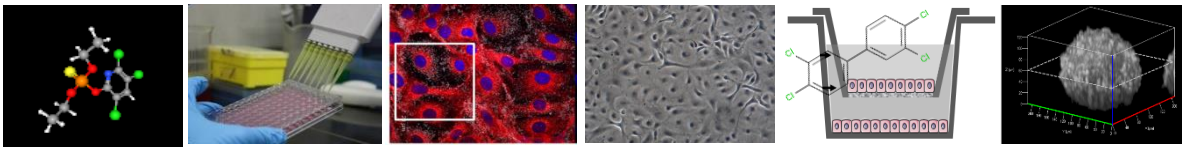
Degree projects in our group typically address a **well-defined research question** (usually a small scientific problem) related with one of the ongoing research projects. The project/study is planned together by the supervisor and the student, offering you the **possibility to include** your **own research interests and learning goals** (e.g., interest in a specific method). In general**, projects** are **well structured** and comprise a series of experiments, which –depending on the results obtained– may give rise to a **conference contribution** and or **scientific publication**. You will receive **training** in the **scientific method** and a variety of **important laboratory techniques** before and during your project. The spectrum of techniques varies dependent on the research question addressed. Typically, it encompasses **nanomaterial characterization** techniques (dynamic light scattering, transmission electron microscopy), **cell culture-techniques** and or working with live **fish** (or aquatic invertebrates), different **molecular biology and biochemical techniques** (cell/tissue homogenization, preparation of subcellular fractions, RNA isolation and quantification, cDNA synthesis, qPCR, enzyme activity assays, toxicity assays), as well as measurement of **physiological and behavioral endpoints.** In addition, while carrying out your degree project in our group, you will gain an insight into how it is to work in an **international, multi-cultural research environment.**

Contact

If you are **interested in carrying out an internship or degree project (Bachelor or Master level)** in nano-ecotoxicology, would like to have **more detailed information** on potential projects, and or discuss **own project ideas**, please do not hesitate to **contact us.**

Email:
tobias.lammel@bioenv.gu.se

Dr. Tobias Lammel
Department of Biological and Environmental Sciences
University of Gothenburg (Sweden)



Fish cell-based *in vitro* methods

Can we use alternative methods to predict the toxicity of chemical substances and thus avoid animal testing?

General background

Chemical substances placed on the European market **need to be assessed if they are hazardous to** the environment including **aquatic organisms**. Most regulatory frameworks (e.g., REACH) demand that chemicals with a specific set of properties and annual production above a given threshold level are tested for their acute toxicity, bioaccumulative potential and long-term toxicity in **fish**. **Acute toxicity**, **bioaccumulation** and **long-term toxicity** is typically tested on **live animals** (*in vivo*-studies). *In vivo* studies, however, are not only expensive but also, and above all raise **strong ethical concerns** due to **suffering and killing of animals**.

During recent years enormous efforts have been undertaken to develop **alternative test methods** which **can help to reduce the amount of animals** used in chemical toxicity testing (**3*R*'s** = ***Reduction, Refinement, Replacement* of animal tests**). However, most efforts have concentrated on developing methods to predict chemical toxicity in humans. **Alternative methods that can predict the toxicity of environmental pollutants in aquatic vertebrates are still scarce**.

Our research

In our laboratory, **we aim at developing alternative test methods based on continuous fish cell lines,** which can help to **reduce the number of fish** that nowadays is used in regulatory **chemical toxicity testing**.

For instance, in the ***sph3roiD project*** we aim at developing an **organotypic *in vitro* model from a fish liver cell line** which can be used to assess and predict **hepatic clearance, bioaccumulation** and **chronic liver toxicity testing** of **chemical substances** in **fish** (including manufactured nanomaterials).

For this purpose, we grow (culture) fish liver cells in form of **three-dimensional (3D), spherical micro-tissues** (so called ***spheroids*** or ***organoids***) which assists in restoring **liver-specific properties** (e.g., high expression levels of detoxification enzymes) and **better mimics the original tissue/organ environment**.

Your project

Each semester (spring and autumn) we offer one highly motivated student to work with us in the *sph3roiD project* (see above). The student will be **directly involved in the ongoing research activities**, i.e., work at the forefront of research in this **exciting emerging area**. The project will address a **well-defined research question** (i.e., a small scientific problem), which can be successfully addressed within the time you have available of your thesis. In general, we aim that students get the possibility to convert their results into a **conference contribution** and or **scientific research article**, which may give them an advantage during potential later PhD applications. As a Bachelor or Master student in our group, you will receive **training** in the **scientific method** and a variety of **important laboratory techniques.** The spectrum of techniques varies dependent on the specific research question addressed, but typically includes different **cell culture-techniques** (freezing/thawing of cells, maintenance and sub-culturing of cells, seeding of cells, cell homogenization, preparation of sub-cellular factions, etc.), **molecular biology techniques** (RNA isolation and quantification, cDNA synthesis, qPCR), **biochemical techniques** (protein determination, enzyme activity assays, cytotoxicity assays), and microscopy techniques (e.g., sample preparation for light, fluorescence and or electron microscopy, image analysis). In addition, carrying out your degree project in our group, you will gain experience in working in an **international, multi-cultural environment.**

Contact

Contact

If you are **interested in carrying out an internship or degree project (Bachelor or Master level)** in environmental *in vitro* toxicology, would like to have **more detailed information** on potential projects, and or discuss **own project ideas**, please do not hesitate to **contact us.**

Email:
tobias.lammel@bioenv.gu.se

Dr. Tobias Lammel
Department of Biological and Environmental Sciences
University of Gothenburg (Sweden)