Zebrafish, Extracellular Vesicle Biology & Theranostic RNA Origami

Yuya Hayashi

Extracellular Vesicle Biology Group (MBG)
Laboratory for Bioinspired Nanomedicine (iNANO)

e-mail: yuya.hayashi@mbg.au.dk
web: mbg.au.dk/yuya-hayashi/

What we do

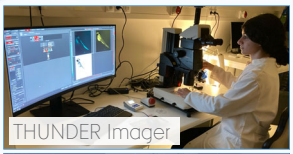
Seeing is believing. We use zebrafish as a model to "visualize" unsolved mysteries in biology – the role of extracellular vesicles (EVs) in health and disease.

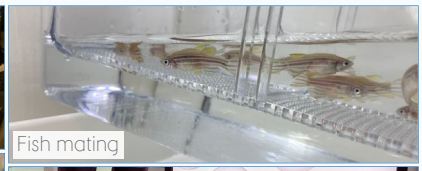
What messages are delivered to regulate the recipient cells? How can we translate the EV biology into novel therapeutics? With zebrafish as our little partners, we seek answers to these questions by nanoscience approaches, genetic engineering, bioinformatics and live imaging of transgenic zebrafish embryos.

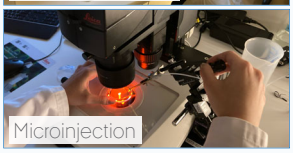
So, what is our goal?

We aim to redefine today's knowledge in cell biology and to advance the nanomedicine field by *learning*, *manipulating* and *mimicking* nature's smart biomolecular architecture, EVs.

Project Opportunities





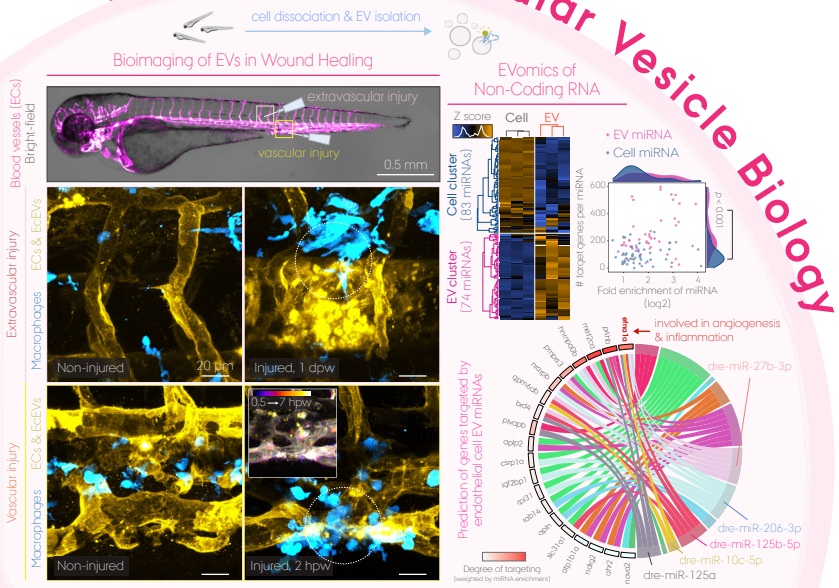


We offer training in modern molecular biology & bioimaging techniques for experiments using zebrafish embryos.

- Bioimaging of zebrafish embryos and image analysis
- Microinjection of nucleic acids/proteins/nanoparticles
- Plasmid construction (design, PCR and DNA assembly)
- Transformation, transfection and transgenesis
- Gene and miRNA expression profiling (qPCR & dPCR)
- SDS-PAGE and Western blotting

...and also thesis writing skills!

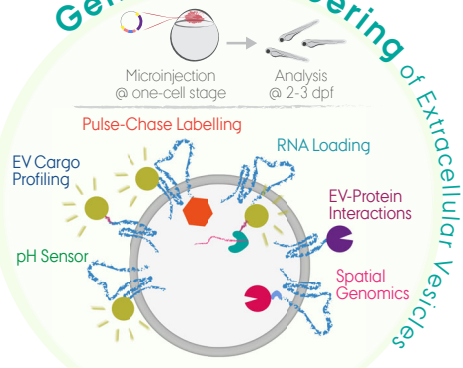
Projects in Extracellular Vesicle Biology



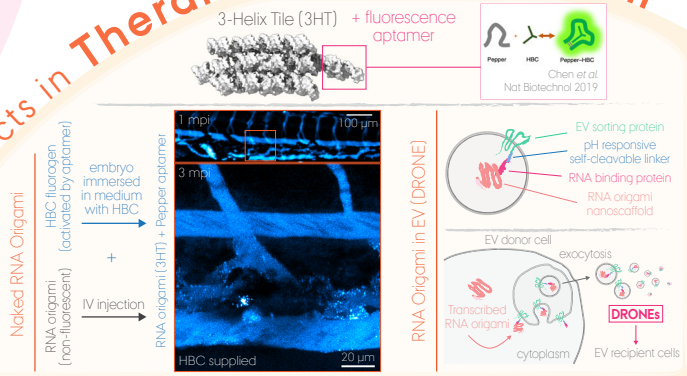
Using zebrafish embryos as an *in vivo* model, we study EVs of various origins on their dynamic behaviour in real-time and how they are received by cells in response to tissue injury, (neuro-)inflammation and regeneration. Bioinformatic approaches are used to profile non-coding RNA cargo of EVs "in transit" from donor cells and to predict target genes regulated in the recipient cells.

Our aim is to capture snapshots of the conversation between cells for novel inspirations that can ultimately give birth to homing nanomachines autonomously searching and fixing organs from inside our body.

Genetic Engineering of Extracellular Vesicles



Projects in Theranostic RNA Origami



RNA origami uses RNA as molecular building blocks that self-assemble into programmable 3D nanoscaffolds. We develop RNA origami for theranostics (therapy + diagnostics) using zebrafish to screen its stability, multi-functionality and potential immunogenicity. Naked RNA origami is in-vitro synthesized with chemical modification for injection into the blood. Another approach is to have cells transcribe RNA origami and encapsulate it in EVs for packaged delivery to where EVs naturally go. In both cases, our goal is to realize safe-by-design RNA origami nanoscaffolds with modular functionality e.g. by incorporating aptamers and cleavable miRNAs.

More about the group?

Visit our group webpage (QR on the left) to find more about the student projects and techniques you can learn with us.

You can also watch fancy movies of extracellular vesicles circulating in the blood and macrophages capturing those nanoparticles!