Project 1.9 Evolution and function of astrocytic extracellular vesicles

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Background:

Astrocytes, which belong to a group of non-excitatory brain cells collectively referred to as macroglia, play defensive and homeostatic roles in the brain parenchyma. Yet, the functions of astrocytes are not only housekeeping. Indeed, astrocytes regulate neurogenesis, the formation and pruning of synapses, and synaptic plasticity, thus the higher-level brain functions. Further underlying their fundamental role, virtually all neurological and neuropsychiatric disorders feature astrocytic dysfunctions. Astrocytes have changed markedly during evolution – human astrocytes are bigger and more complex, in comparison to their primate counterparts. The genetic basis of astrocyte evolution is largely unknown and are subject of our investigations.

Proper development and brain functions require coordinated communication between cells. All cells in our body, thus also in the brain, produce extracellular vesicles (EVs)–small, lipid-made structures that carry information over long distances between cells or even organs. The biological cargo transported in EVs includes proteins or nucleic acids. EVs are produced by the “sender cells” and delivered to the “recipient cells”, where they can impact various processes. Non-coding RNAs (miRNAs), are a fascinating group of cargos, as they can directly control the expression of genes in the recipient cells. Recently, we found that EV-related genes are activated in primate astrocyte evolution and EV production is enhanced in the human lineage (Ciuba et al., 2025, Cell Stem Cell). Given the profound changes in astrocyte biology in humans, we hypothesize that the cargos of EV produced by astrocytes (including miRNAs) also changed in evolution. Yet, the involvement of EVs in brain evolution is unknown.

Aim:

The project aims to identify and scrutinize astrocytic EV-carried miRNAs that are enhanced or gained in the human lineage. We will employ human and chimpanzee induced stem cell models, genome editing techniques, and cutting-edge molecular biology methods to study the impact of particular, evolutionarily-affected miRNAs on neuron development and function. Moreover, we will apply 3D organoid models (so-called “mini-brains”), which mirror early brain development stages, to investigate the role of chosen miRNAs in brain development.

Requirements:

- Master’s degree in molecular biology, neurobiology, biotechnology, or genetics,
- hands-on laboratory experience (especially cell culture, molecular biology techniques),
- experience in microscopy and/or flow cytometry would be an advantage,
- proficiency in English.