ESR9 - Evolution of microswimmer designs in distinct micro-environments

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Microbial parasites thrive in or on most living beings. Their strategy is to persist, rather than to kill quickly. Among the prototypic parasites, the trypanosomes are most versatile and best studied examples. An enormous range of trypanosome species infect basically all animals, and in humans, they cause deadly diseases. We study the African trypanosomes that are transmitted by the infamous tsetse fly, and cause sleeping sickness. These trypanosomes undergo several genetically programmed stage transitions in the mammalian host and in the insect vector. All life cycle stages are basically variations over the same construction theme, as they feature a single flagellum, uniquely attached alongside the spindle-shaped cell body. The motion capabilities and properties, however, vary considerably between the trypanosome forms. We therefore hypothesize that evolution has shaped the individual parasite stages for maneuvering in distinct micro-environments, such as human skin and adipose tissues tissue spaces, blood circulation and brain, as well as the complex digestive system of the tsetse fly. We aim at reproducing these environments and measuring, manipulating and simulating the swimming behavior of evolutionary adapted and naïve parasites therein.

In this project the Early Stage Researcher (ESR) will work on the nature-inspired construction of complex microfluidic architectures, using light-sheet microscopic 3D-maps as high-resolution templates. Capillaries of the human bloodstream, tissue spaces, the blood-brain barrier and the tsetse fly alimentary tract will be emulated. This includes geometric parameters, but also physicochemical and flow properties. The student will do comparative 4D-analysis of flagellar beating dynamics and swimming behavior of all trypanosome life cycle stages ex vivo in distinct artificial environments. Particular focus will be on emergent collective motion pattern, as well as chemo- and mechanotactic decision making. This includes the inducible formation of trypanosome swarms on a solid support. Computer-simulation of different trypanosome designs and swimming styles, including behavior in flow, confinement and in the presence of obstacles will be performed. Special emphasis will be on probable designs that are not existing, but could emerge as extinct evolutionary intermediates.

Salary: The PhD salary is based on the regulations of appointment and remuneration for Marie Skłodowska Curie Fellows in ITN networks. The successful candidate will also benefit from additional funding for several visiting trips (typically 1 month each) in the partner teams.
Requested profile: We welcome highly-motivated applicants holding a MSc and with excellent background in theoretical physics, biophysics, and/or soft matter physics.
Further obligations: The ESR is expected to travel to network partners for secondments and a mini-project for durations up to 2-3 months. In addition, the ESR participates in outreach activities (social media, participation in public events), as well as dissemination to popular press.
Funding conditions: Candidates must not have resided or carried out their activities - work, studies, etc.- in Germany for more than 12 months in the 3 years immediately before starting the PhD.
Hiring procedure: Applications (CV, transcript of studies, statement of motivation and at least one letter of recommendation) should be sent by email to Markus Engstler (markus.engstler@biozentrum.uni-wuerzburg.de). The recruitment is taking place following the European Code of Conduct for Recruitment of Researchers which all candidates are encouraged to study.
Selection process: PHYMOT is open to researchers regardless of gender, religion, ethnicity, disability, sexual orientation, political views, language, age and nationality. Applications from highly qualified applicants from outside the EU will thus be equally considered to other applicants. The integration of refugees is an EU priority and we will ensure equal opportunities to the researchers whose scientific careers have been interrupted. To ensure a gender balance in the project and work towards the Commission's own policies on narrowing the gap between the genders in research, should two applicants be found to be equally qualified the preference will be given to the one that will balance the gender distribution in the entire Network. All submitted applications will be checked against the defined admissibility and eligibility criteria (e.g. submitted electronically, readable, complete, in English, including grades and references), and applicants will be informed by email within two work weeks on the outcome. Evaluation criteria include: Scientific background (with particular focus on

theoretical physics), previous publications, capacity for creativity and independent thinking and leadership, mentoring and presentation abilities.

Protection of personal data: The personal data of the applicants will be handled in compliance with applicable EU and national law on data protection (GDPR).

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