Mathematical Modelling of the mobility of Trypanosomes

Problem raised by

Centre of Mathematical Biology, Oxford

Coordinators:

Dr. Heike Gramberg (University of Oxford)

Dr. Antonio Bru (Universidad Complutense de Madrid)

Exposition of the problem:

Trypanosomes are a group of kinetoplastid one-celled organisms. All members in this group are parasitic, and are primarily found in insects, although some species have a secondary host. There are several species in the group of Trypanosomes that can infect humans, causing major diseases such as sleeping sickness in Africa and Chagas disease in South-America

Trypanosomes are characterized by having one single flagellum. They move around by beating this flagellum back and forth similar to for example sperm cells, with this difference that the flagellum of Trypanosomes is pointing in the direction of the flow so that it is pulling itself through the fluid instead of pushing. The movement of the flagellum is driven by an internal sliding force between pairs of inextendible fibres along the length of the flagellum causing local bending of the flagellum. The sliding force is balanced by a bending force due to the bending stiffness of the flagellum and the viscous shear forces acting on the surface of the flagellum and the cell body.

The aim of this problem proposal is to derive the equations of motion, and to investigate the motion of the Trypanosomes by varying the material properties of the flagellum such as the bending stiffness and the profile of the sliding force along the length of the flagellum.

Scheme of the work to be done:

1) Introduction of the general problem..

2) Derivation of the differential equations and boundary conditions describing the displacement of the flagellum. Use an appropriate scaling to derive a set on non-dimensional equations.

3) Study the simplified case where the displacement of the flagellum is small compared to the length of the flagellum. This leads to a set of linear equations for which there exists an analytic solution. Study the influence of the material properties of the flagellum on this solution.

4) Numeric solution of the full problem.