Biological and bio-inspired locomotion at small scales

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ABSTRACT

Locomotion at the (tens of) micron scale is at the root of many fundamental processes in Biology. These include the immune system response, the migration of metastatic tumour cells, and sperm cells successfully swimming their way by beating a flagellum until they reach and fertilise an egg cell. Besides their biological interest, motile cells provide a template for the bio-inspired design of micro-meter-scale, self-sufficient machines capable of executing controlled motion.

We will report on some of our recent studies on swimming micro-motility, discussing general principles first, and then a concrete case study.

General principles are obtained by regarding locomotion as a control problem, in which propulsive forces are generated by the interaction of a deforming body with the surrounding fluid. We will highlight some conceptual principles that may inspire the design of engineered bio-inspired devices.

The case study concerns the amoeboid motion of Euglena, which is based on dramatic shape changes [1]. These are accomplished thanks to a complex structure (pellicle) underlying the plasma membrane, made of interlocking proteinaceous strips, microtubules, and motor proteins. We study the mechanisms by which the sliding of pellicle strips leads to shape control and locomotion, by means of both theory and experiments. A new concept of surface with programmable shape emerges from these studies.

REFERENCES

[1] M. Arroyo and A. DeSimone, "Shape control of active surfaces inspired by the movement of euglenids", *J. Mech. Phys. Solids*, Vol. **62**, pp. 99–112, (2014).