Biology 427 Posters Due Mon Dec 5, 5 pm Lecture 26. Life at Low Reynolds Numbers II

- Low Reynolds numbers recap
- •Flagellar mechanisms
- Ciliary mechanisms (challenges)
- •The mechanics of the cilium/flagellum

Life at Low Reynolds numbers (Re <<1)

Phenomenological issues:

- disturbances are manifest over huge relative distances.
 (boundaries are all important)(to swim is to scream)
- inertia is negligible
- flow is reversible (flow equations are linear)
- shape matters considerably less (no wakes)



Mymarid wasps: paddles versus rakes









http://www.cco.caltech.edu/~brokawc/Demo1/BeadExpt.html



Copyright © 2006 Nature Publishing Group Nature Reviews | Microbiology Bacterial flagella operate like a corkscrew, driven by a proton gradient (high H⁺ outside).



recent history & movie of a bacterial flagellum.

https://www.youtube.com/ watch?v=v1NnMmw8v80

Clip from Nova https://www.youtube.com/ watch?v=a_5FToP_mMY

How is ciliary and flagellar bending controlled?











$$D = \frac{4\pi\mu U\mu l}{\ln\left(\frac{l}{a}\right) + 0.193}$$
 Cross flow

$$D = \frac{2\pi\mu U\mu l}{\ln\left(\frac{l}{a}\right) - 0.897}$$
 Longitudinal flow

Wave Propagation

Two questions:

 What are the cellular

mechanisms that generate force?

 What are the fluid dynamic mechanisms that propel the animal?



Assume *l* >> *a* so that the normal drag is twice the tangential drag. Draw the drag forces on the two sections of this flagellum and decompose those into thrust and lateral forces.



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Cilia — where are they deployed and how do they work?



https://www.youtube.com/watch?v=pUIBABE5b6A



https://www.youtube.com/watch?v=j3CuqRDGPmU



Ciliary metachronv and the envelope model (Brennan, Wu

Mucociliary transport and the shear layer model (Winet)

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perpendicularly to an incident flow is twice that of a cylinder aligned At low Reynolds number, the drag on a cylinder oriented with the flow. Draw a ciliary power stroke and a recovery stroke Exercise: below.

