The Physics of Life

Physics 171: The University of Oregon, Department of Physics

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List of Assigned Readings

Spring Term, 2014

PDFs of all the materials below are available from R. Parthasarathy by request.

Introductory (and supplementary) materials: math and scientific notation

[*recommended*] Chapter 2 of L. Weinstein, J. A. Adam, *Guesstimation: solving the world's problems on the back of a cocktail napkin* (Princeton Univ. Press, Princeton, NJ, 2008).

[*recommended*] Appendix 1 of S. Vogel, *Life's Devices: The Physical World of Animals and Plants* (Princeton University Press, Princeton, NJ, 1988).

Fluids

On Buoyancy – R. Parthasarathy

On Liquids – R. Parthasarathy

S. Basu, "Robots that Walk on Water," *Scientific American* (July 18, 2007)
http://www.scientificamerican.com/article/robots-that-walk-on-water/

The Economist, "Aerial Jellyfish," March 8, 2014.
http://www.economist.com/news/technology-quarterly/21598298-ornithopters-flying-bird-has-long-captured-imagination-latest-way

J. A. Clements, "Surface Tension in the Lungs," *Sci. Am.* **207**, 120–130 (1962).

Scaling, shape, and mechanics

Part of Chapter 3 of "Life's Devices" by Steven Vogel. [S. Vogel, *Life's Devices: The Physical World of Animals and Plants* (Princeton University Press, Princeton, NJ, 1988)].

On scaling and shape – R. Parthasarathy

Chapter 2 T. A. McMahon, J. T. Bonner, *On size and life* (Scientific American Library, New York, 1983). Parts of this were optional, and parts were required. Required: especially the sections on nails, and Kleiber's Law.

Related to our examination of an elephant femur: http://cas.uoregon.edu/2014/02/the-elephant-in-the-room/

On mechanical similarity and bone shape – R. Parthasarathy

[*optional*] from *On Size and Life* by McMahon and Bonner, on "elastic similarity" [T. A. McMahon, J. T. Bonner, *On size and life* (Scientific American Library, New York, 1983)].

Other papers on metabolic scaling, discussed in class:

- West, G. B. & Brown, J. H., "Life's Universal Scaling Laws," *Physics Today* **57**, 36–42 (2004).

One should note that the analysis of the power-law scaling of metabolic rate with mass described here and in related papers, and even the *existence* of universal power-law scaling, are quite controversial; see e.g.

- C. R. White, T. M. Blackburn, R. S. Seymour, "Phylogenetically informed analysis of the allometry of Mammalian Basal metabolic rate supports neither geometric nor quarter-power scaling." *Evolution*. **63**, 2658–67 (2009).
- [An interesting-looking paper I haven't read:] J. L. Maino, M. R. Kearney, R. M. Nisbet, S. A. L. M. Kooijman, "Reconciling theories for metabolic scaling." *J. Anim. Ecol.* **83**, 20–29 (2014). http://onlinelibrary.wiley.com/doi/10.1111/1365-2656.12085/full
- M. F. Roberts, E. N. Lightfoot, W. P. Porter, A new model for the body size-metabolism relationship. *Physiol. Biochem. Zool. PBZ*. **83**, 395–405 (2010).

Other papers on allometric scaling, discussed in class or assignments:

- [Frog toe pad adhesion] J. M. Smith, W. J. P. Barnes, J. R. Downie, G. D. Ruxton, "Adhesion and allometry from metamorphosis to maturation in hylid tree frogs: a sticky problem." *J. Zool.* **270**, 372–383 (2006). http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7998.2006.00145.x/abstract
- [Simple isometric scaling of lung volume in animals] P. Willmer, G. Stone, I. Johnston, *Environmental Physiology of Animals* (Wiley-Blackwell, 2004).
- [Isometric scaling of cockroaches] H. D. Prange, "The scaling and mechanics of arthropod exoskeletons" in *Scale effects in animal locomotion*, Ed. T. J. Pedley, Academic Press, 1977, p. 169-181.
- [Lobsters] Nauen, J. C. and Shadwick, R. E. "The scaling of acceleratory aquatic locomotion: body size and tail-flip performance of the California spiny lobster panulirus interruptus." *J. Exp. Biol.* **202** Pt. 22, 3181-3193 (1999).

- [Avian genome size and surface area / volume scaling (discussed during the "DNA" section)] See the blurb I wrote at http://eighteenthelephant.wordpress.com/2014/06/02/the-creation-of-the-birds/, and the reference cited at the bottom.

Microscopic / subcellular biophysics

Chapter 1 of "The Machinery of Life," by David S. Goodsell [D. S. Goodsell, *The Machinery of Life* (Copernicus, New York, 2nd ed., 2010).]

On Brownian Motion – R. Parthasarathy

R. M. Mazo, *Brownian Motion: Fluctuations, Dynamics, and Applications*, (Clarendon Press, Oxford, 2002). The book is very technical, but the introductory chapter nicely describes the history of the study of Brownian motion.

On Proteins – R. Parthasarathy

On Membranes – R. Parthasarathy

About DNA:

- From *Molecular Biology of the Cell*: http://www.ncbi.nlm.nih.gov/books/NBK26864/.
- (I wrote a reading on DNA, but didn't assign it.)
- R. Phillips, J. Kondev, J. Theriot, *Physical Biology of the Cell* (Garland Science, New York, 2008) – especially on DNA packaging, and DNA as a random walk.
- E. Segal *et al.*, A genomic code for nucleosome positioning. *Nature*. **442**, 772–778 (2006). [Briefly discussed with some students.]

Viruses:

- From *Molecular Biology of the Cell*: http://www.ncbi.nlm.nih.gov/books/NBK26917/#A4628
- Discussed: A. Evilevitch, L. Lavelle, C. M. Knobler, E. Raspaud, W. M. Gelbart, "Osmotic pressure inhibition of DNA ejection from phage." *Proc Natl Acad Sci USA*. **100**, 9292–9295 (2003)