Macroscopic Laws of Biology

Chris Kempes

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    - Laws of chemistry
    - General processes of natural selection
    - Laws of physics
    - Laws of life?

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$$F = \frac{Gm_1m_2}{r^2}$$

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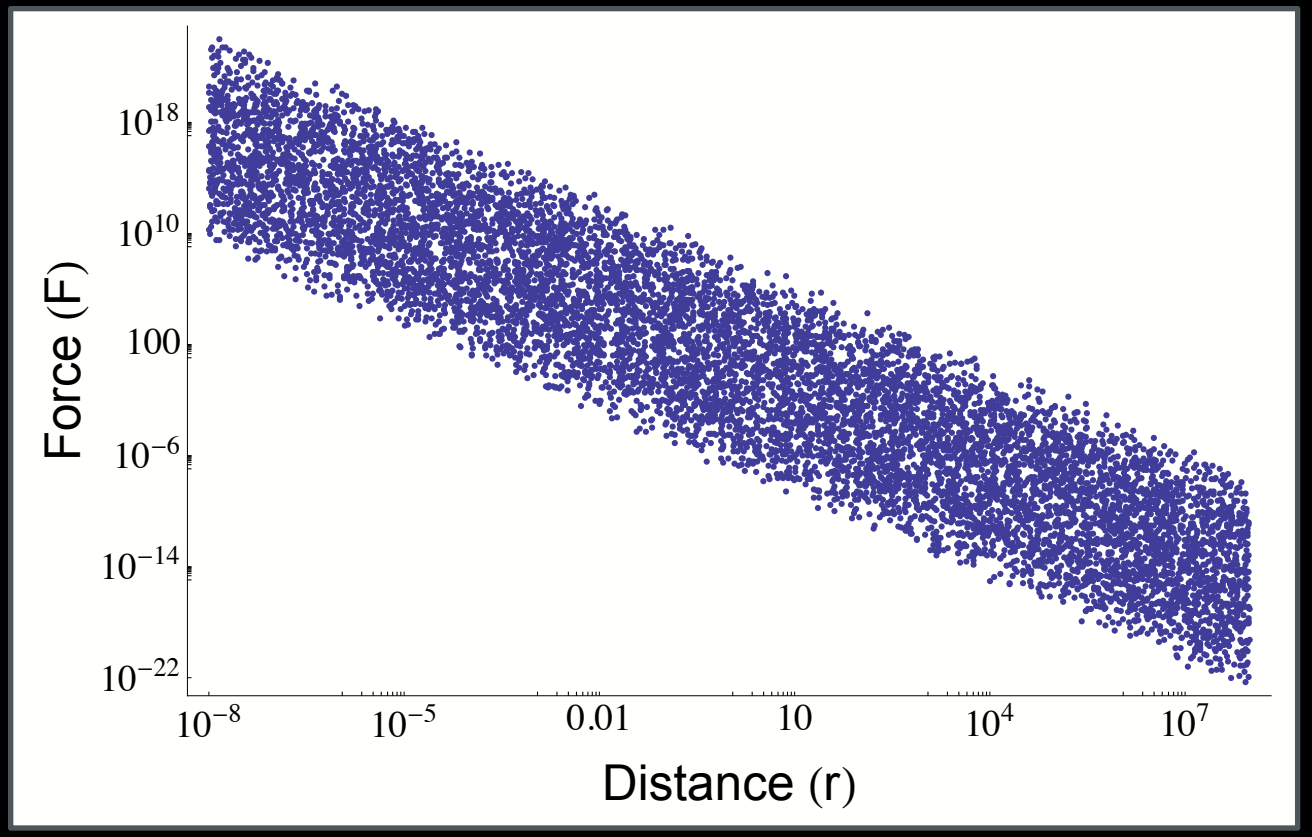

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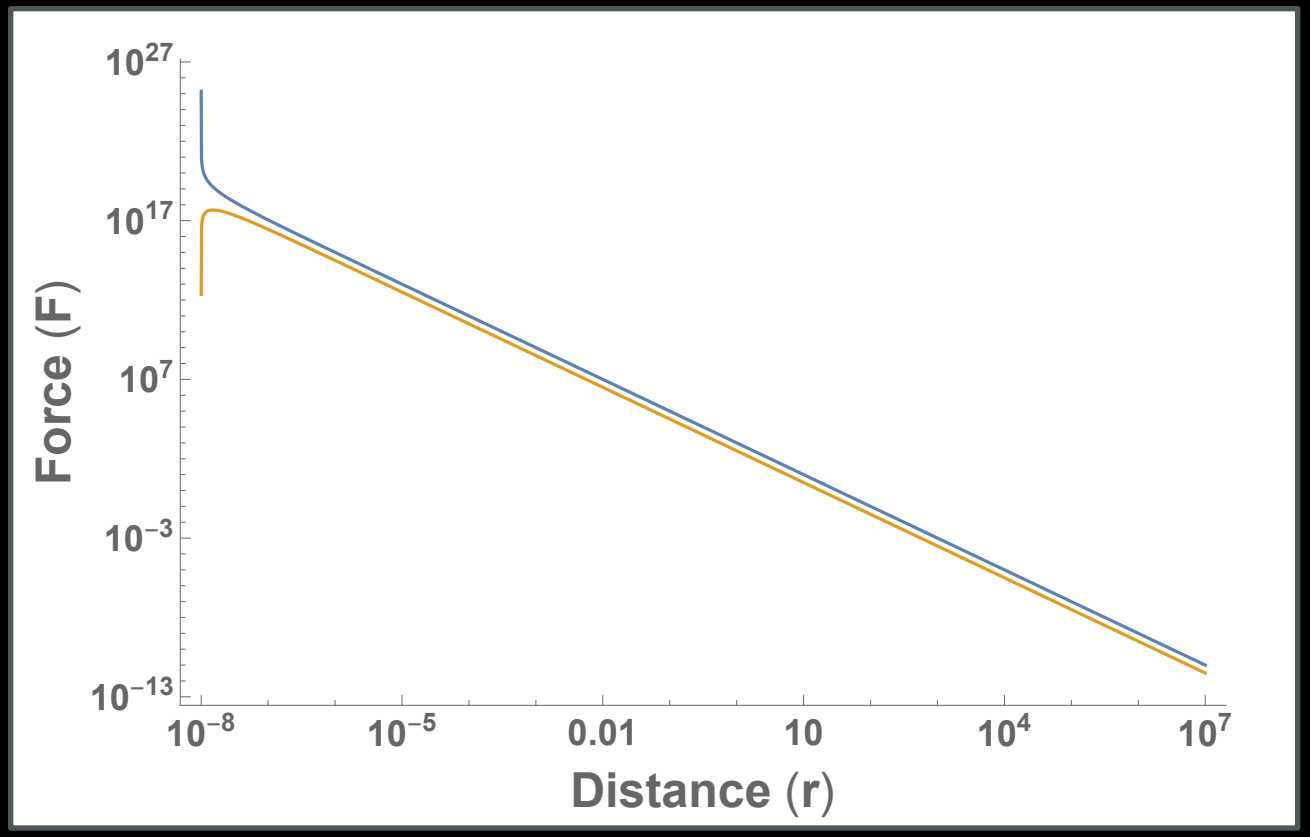

Laws in Biology?

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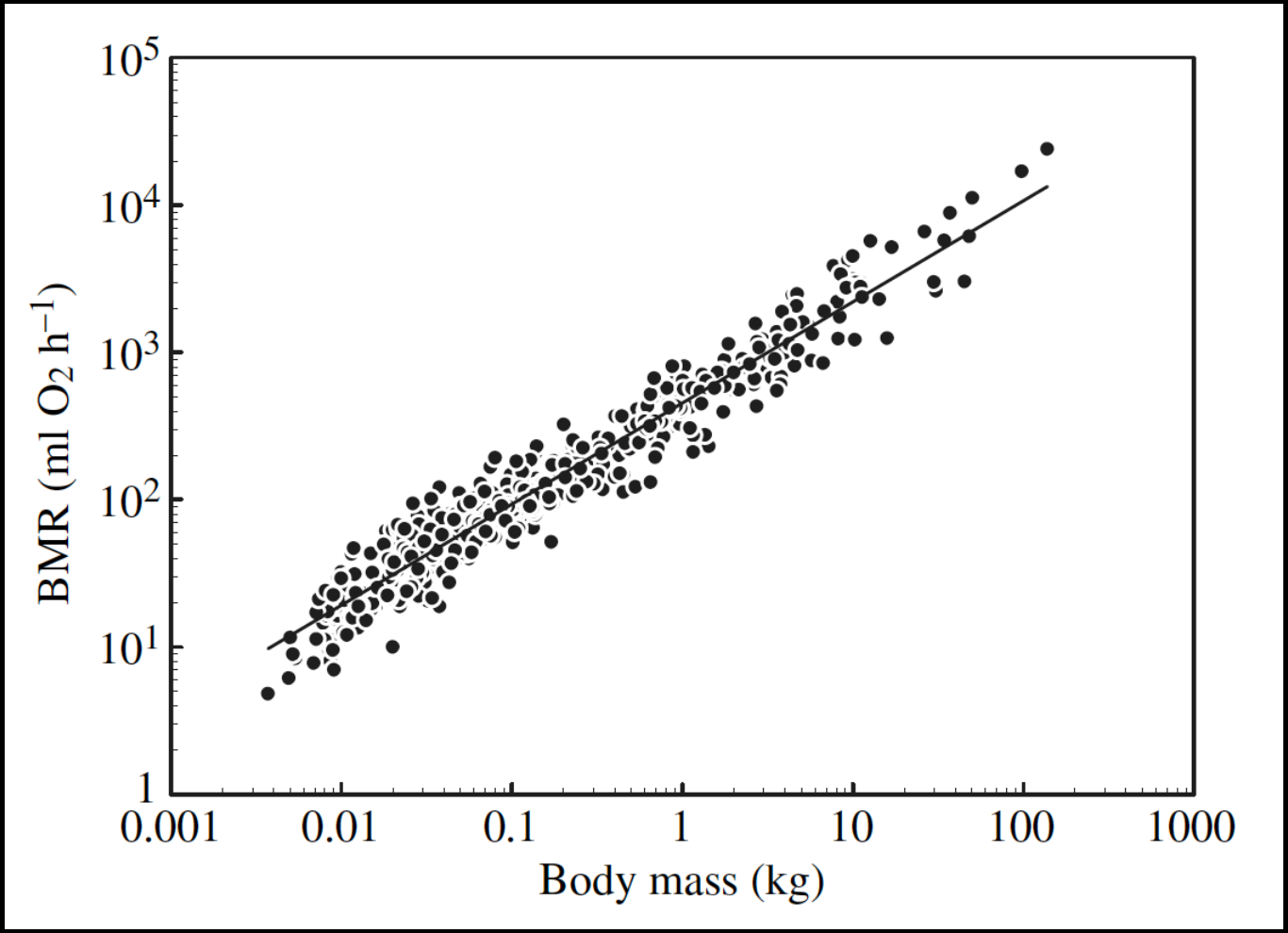
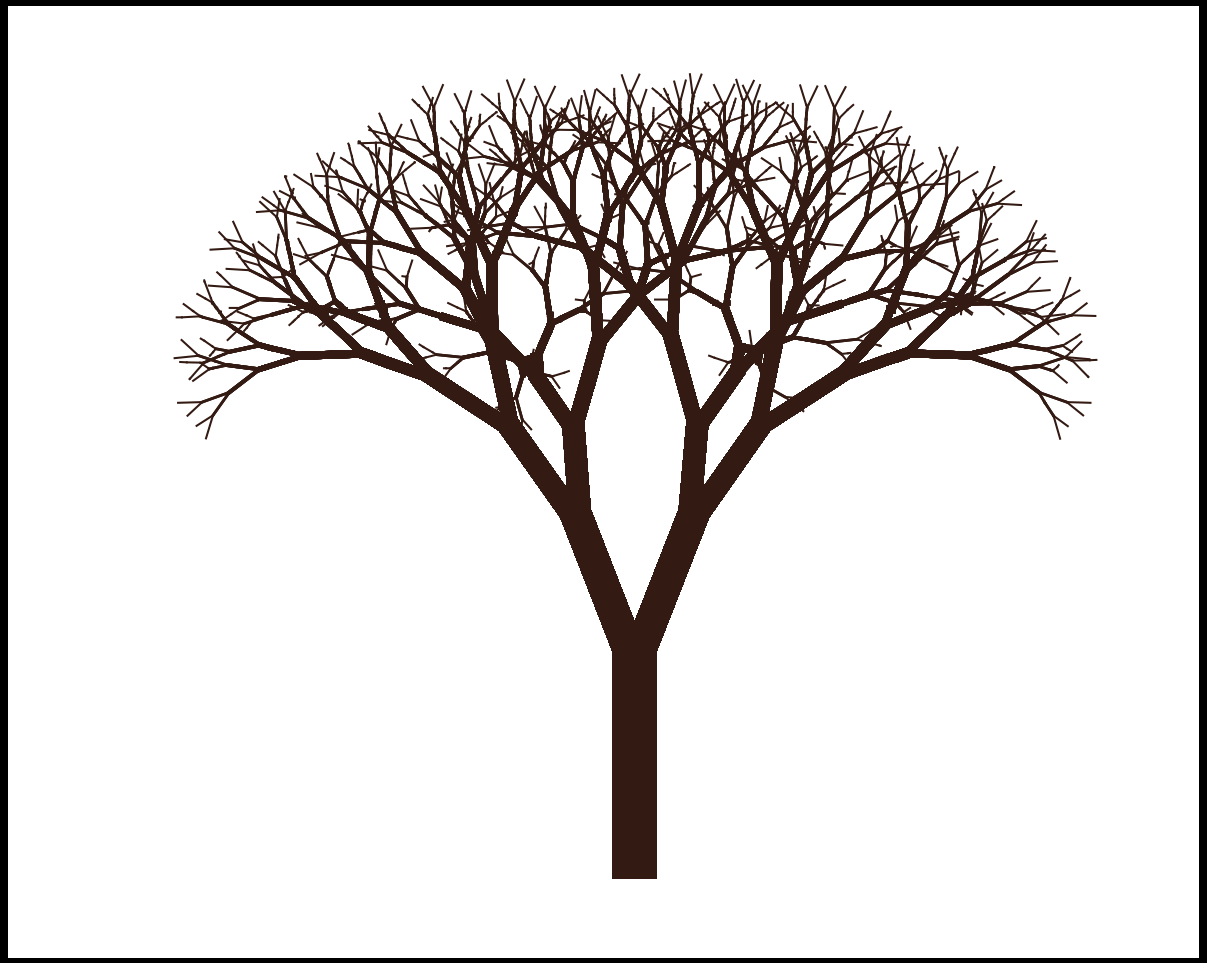
- Organisms evolve within the constraints of chemistry and physics.
- In certain contexts organisms can optimize physiology with respect to physical constants.

An advanced example



White and Seymour, The Journal of Experimental Biology, 2005

An advanced example



West, Brown, and Enquist, Science 1997
Kempes et al. PLoS One, 2011

Fundamental Constraints

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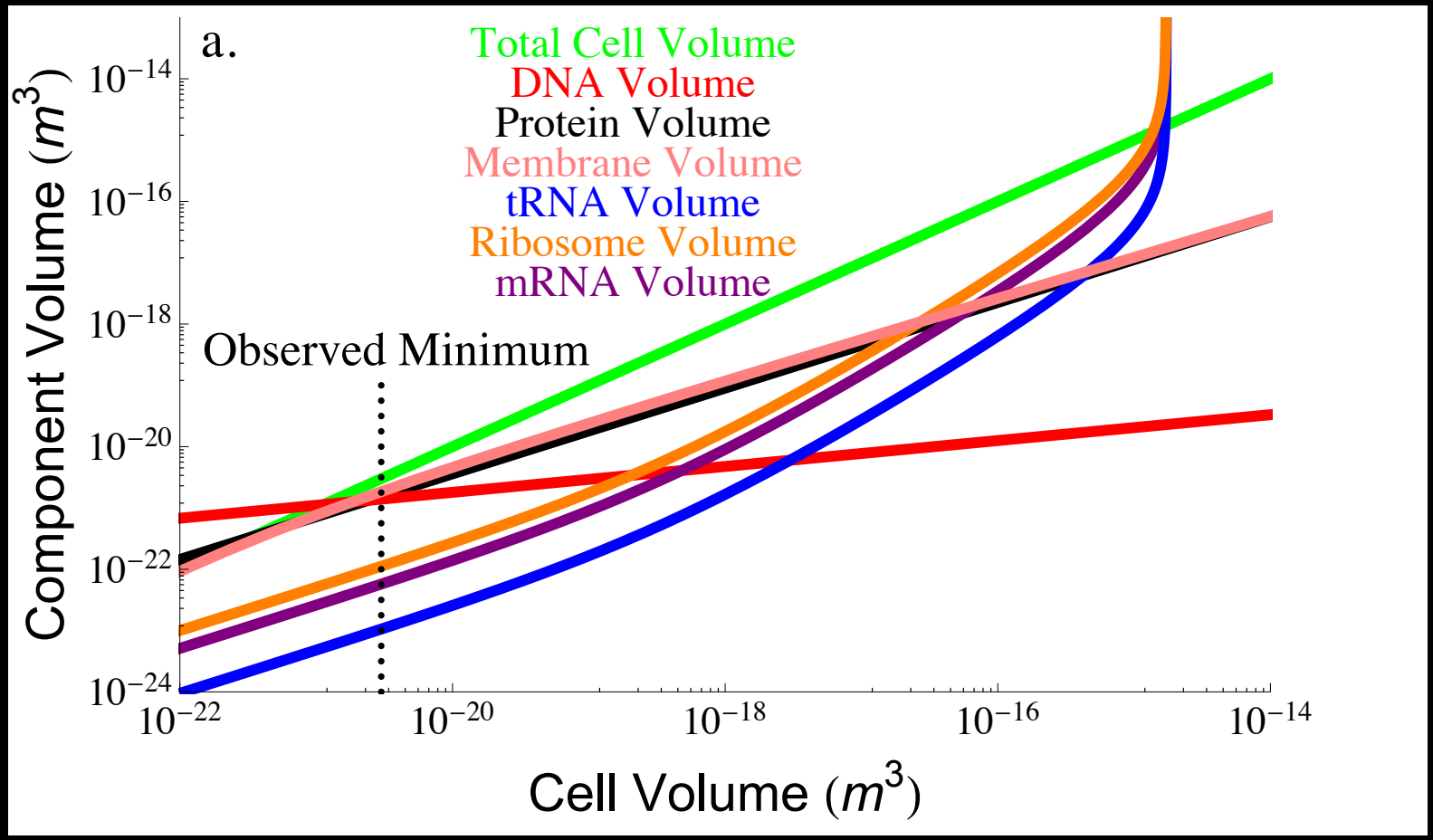
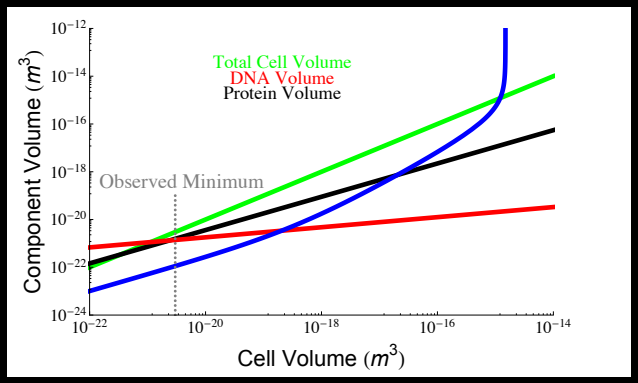
$$U = 4\pi r_c^2 J(r_c) = 4\pi D C_\infty r_c$$

Bacterial Physiology



Kempes, Wang, Amend, Doyle, Hoehler.,
ISME Journal, 2016

Generalized Physiology



all physiological possibilities