Chemical Sub-system

- L1: Introduction to random processes, Brownian motion, and the Boltzmann distribution

- L2: Diffusion as a random walk and the Stokes-Einstein Equation

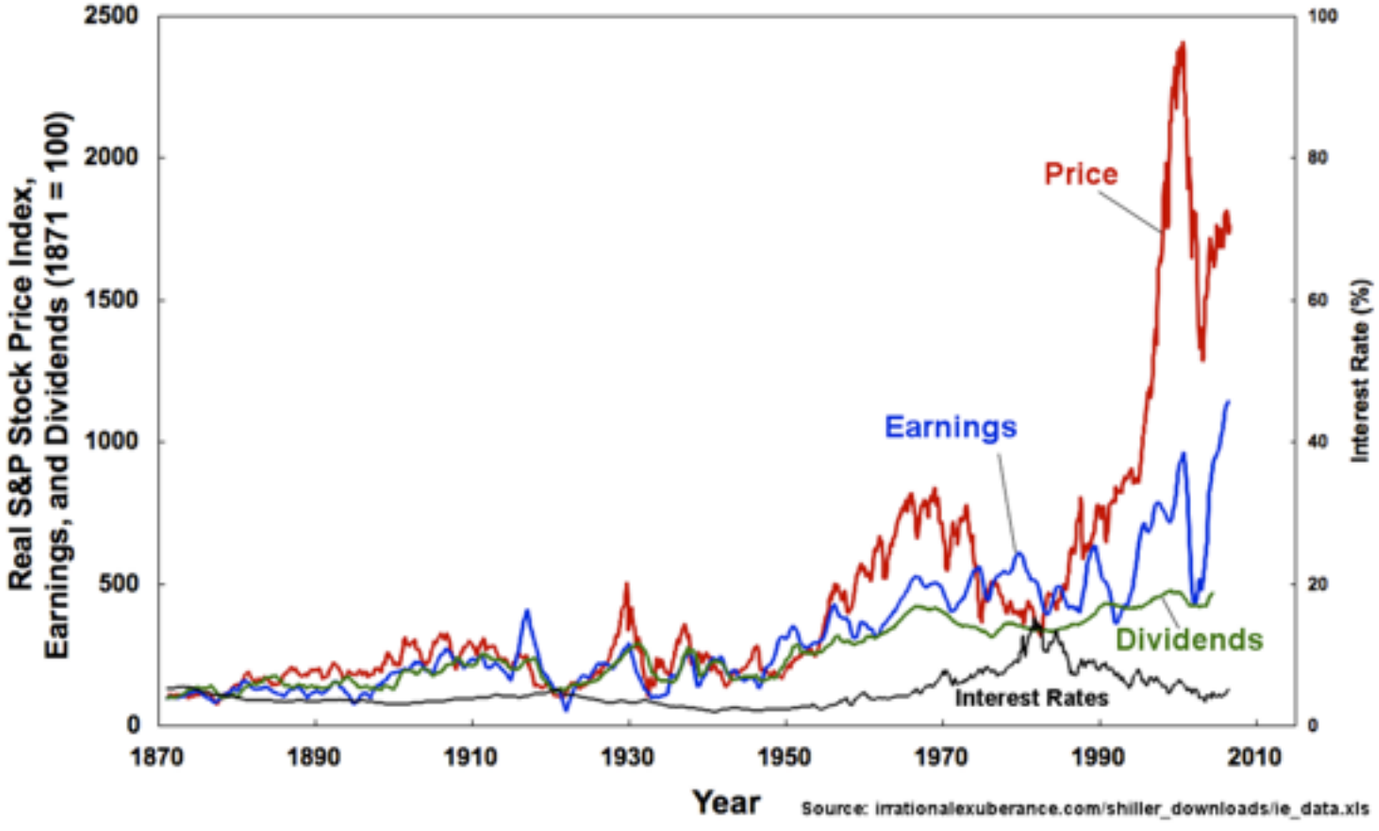
- L3: Fick's Laws and conservation of mass in differential form, steady-state diffusion

- L4: Diffusion with simple binding reactions (e.g., irreversible ligand uptake/degradation or simple production)

- L5: Diffusion with complex binding reactions including ligand diffusion through extra-cellular matrices

What is a Stochastic or Random Process?

In probability theory, a **stochastic** (/stoʊˈkæstɪk/) **process**, or often **random process**, is a collection of random variables, representing the evolution of some system of random values over time. This is the probabilistic counterpart to a deterministic process (or deterministic system). Instead of describing a process which can only evolve in one way (as in the case, for example, of solutions of an ordinary differential equation), in a stochastic or random process there is some indeterminacy: even if the initial condition (or starting point) is known, there are several (often infinitely many) directions in which the process may evolve.



Brownian Motion

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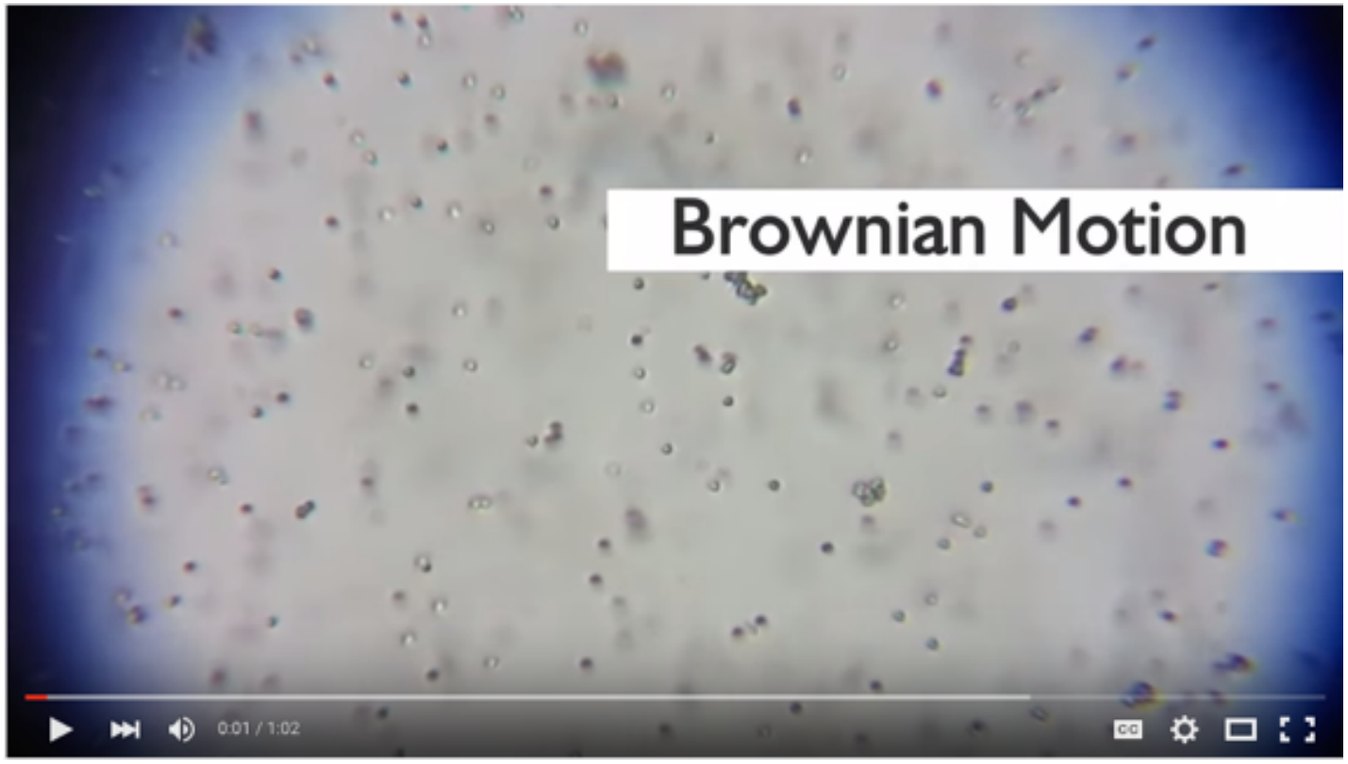

Brownian Motion

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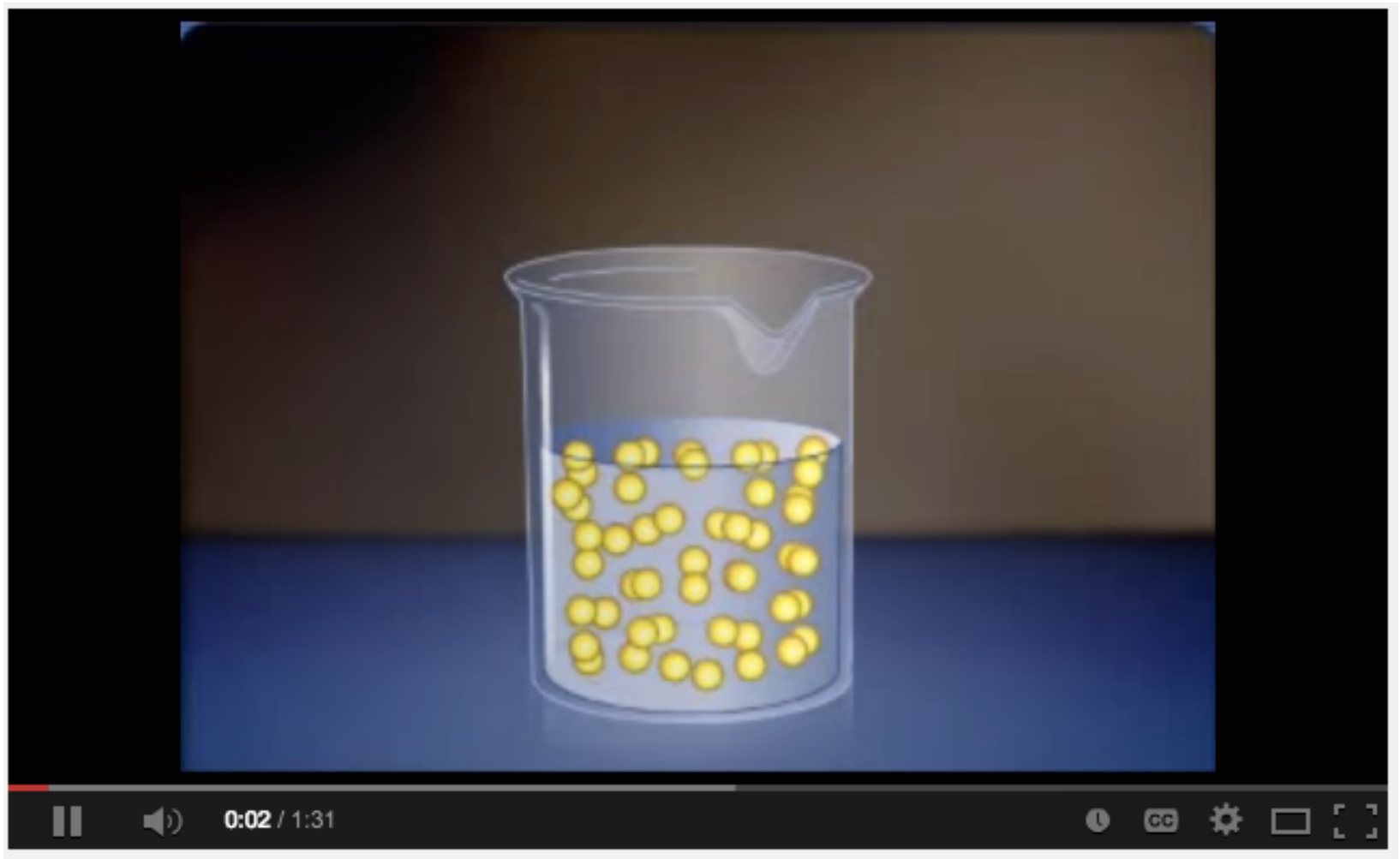
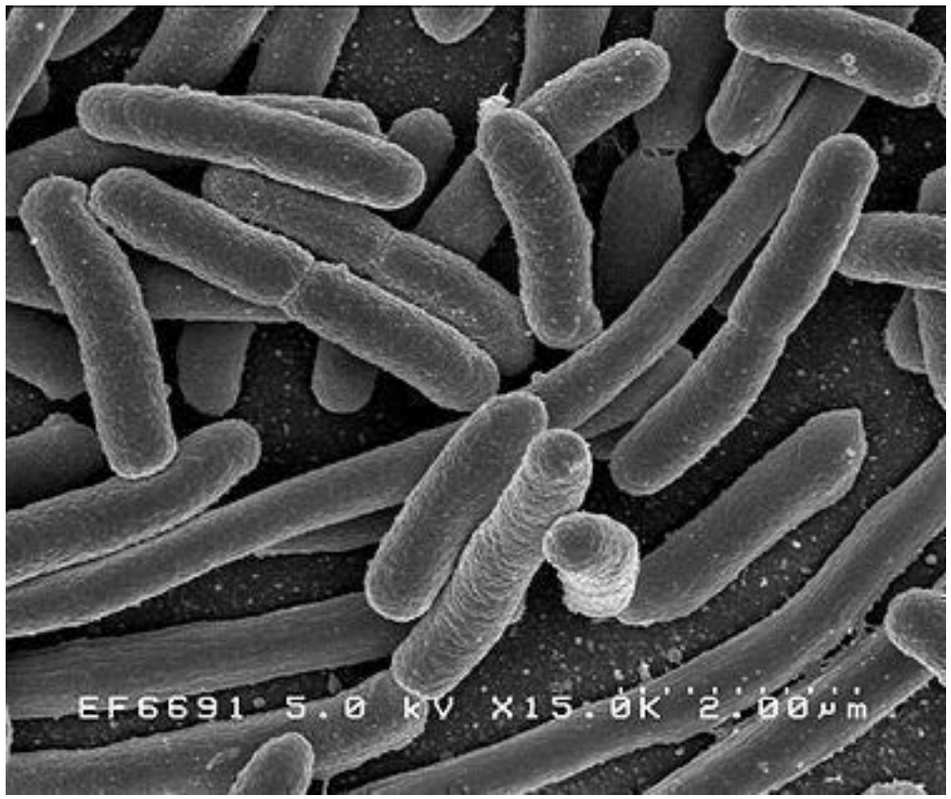
Macroscopically Observed Brownian motion

Microscopic versus Macroscopic Brownian Motion



Brownian Motion inside Cells



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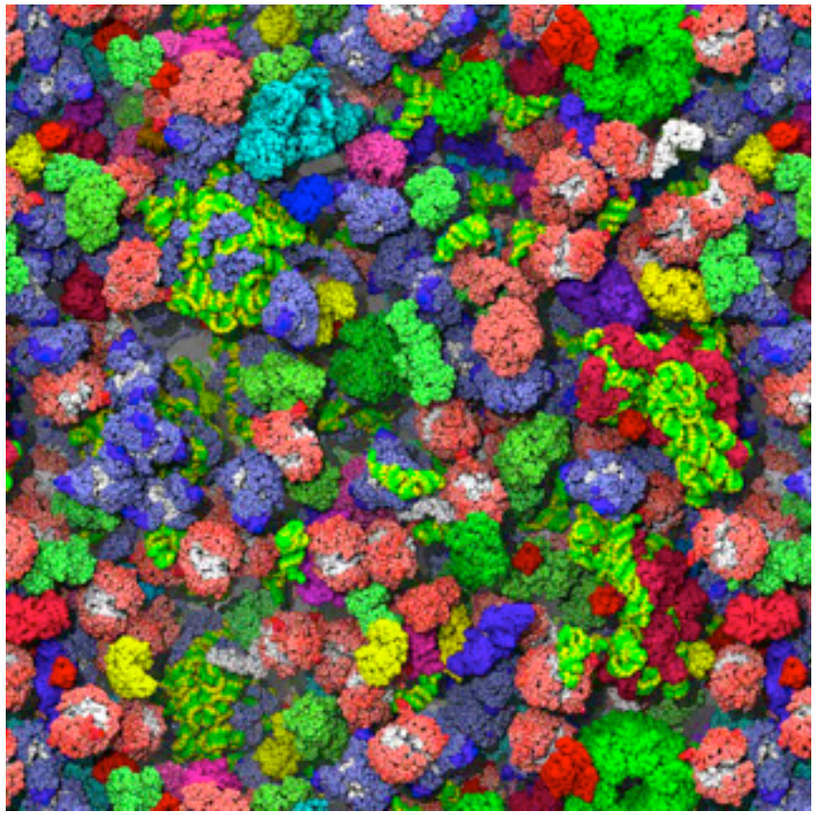

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10 microsecond Brownian Dynamics simulation of 100 proteins in the *E. coli* cytoplasm

(from McGuffee & Elcock, *PLoS CB*, 2010)

How big is an *E. coli* cell?

Brownian Motion inside Cells: Super-resolution Imaging of Ribosomes in a Living *E. coli*

Bakshi et al., *Mol Micro* 2012

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Source: Bakshi, Somenath et al. "Superresolution imaging of ribosomes and RNA polymerase in live Escherichia coli cells." Molecular Microbiology 85, no. 1 (2012): 21-38.

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