

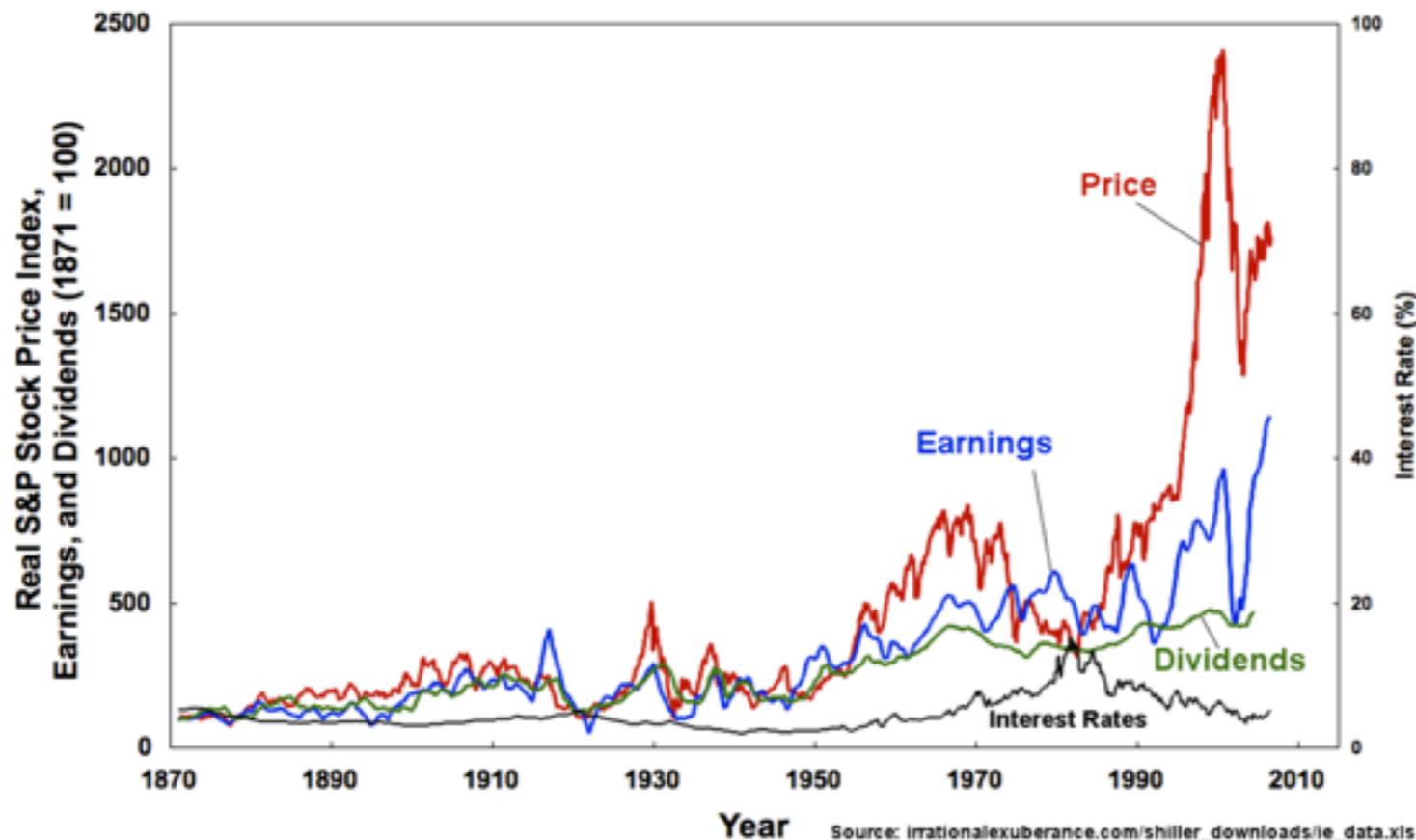
Chemical Sub-system

- 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** ([/stou'kæstɪk/](#)) **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.

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Brownian Motion

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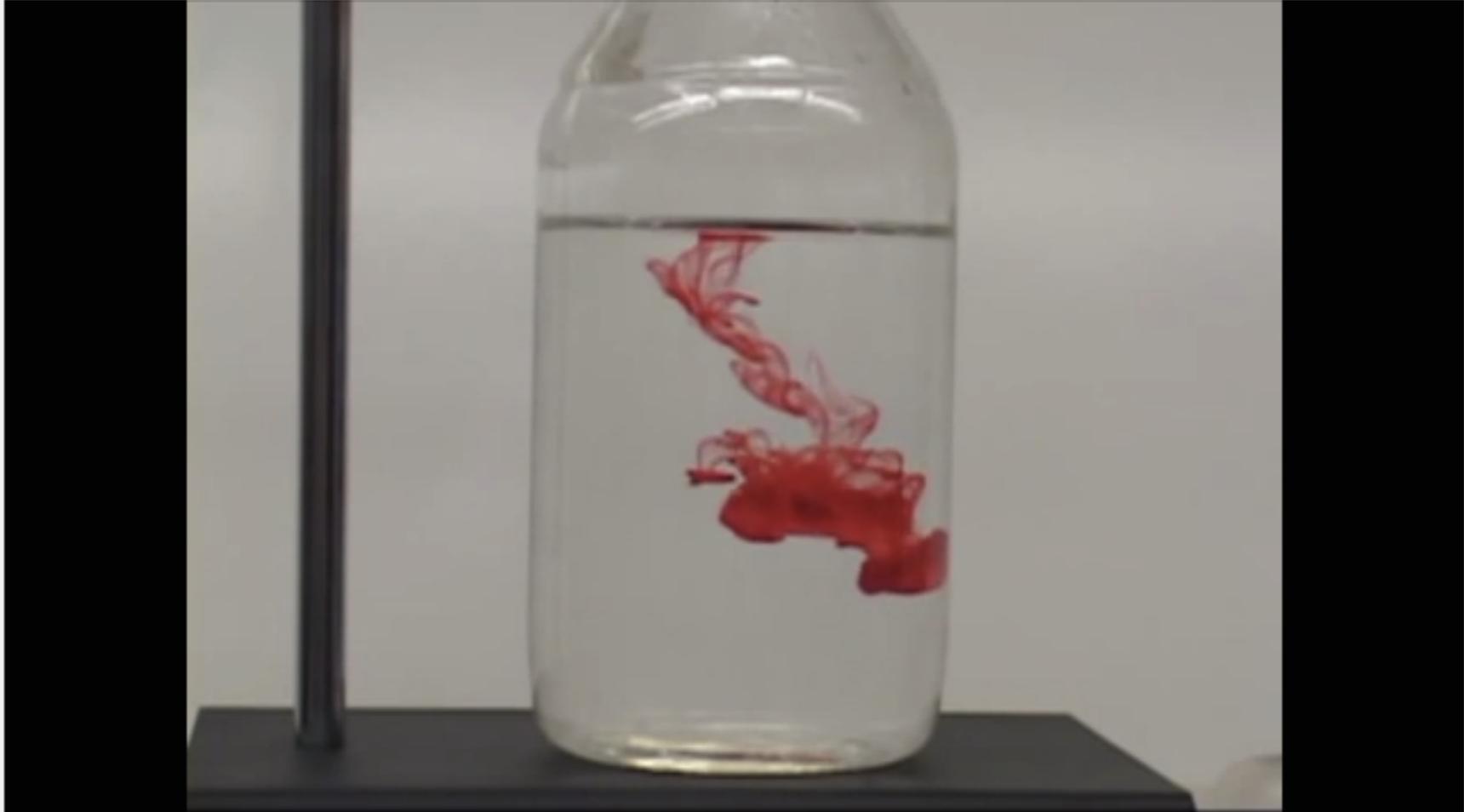
Brownian Motion

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Macroscopically Observed Brownian motion



0:08 / 0:50

Bulk Diffusion of Food Coloring in Water

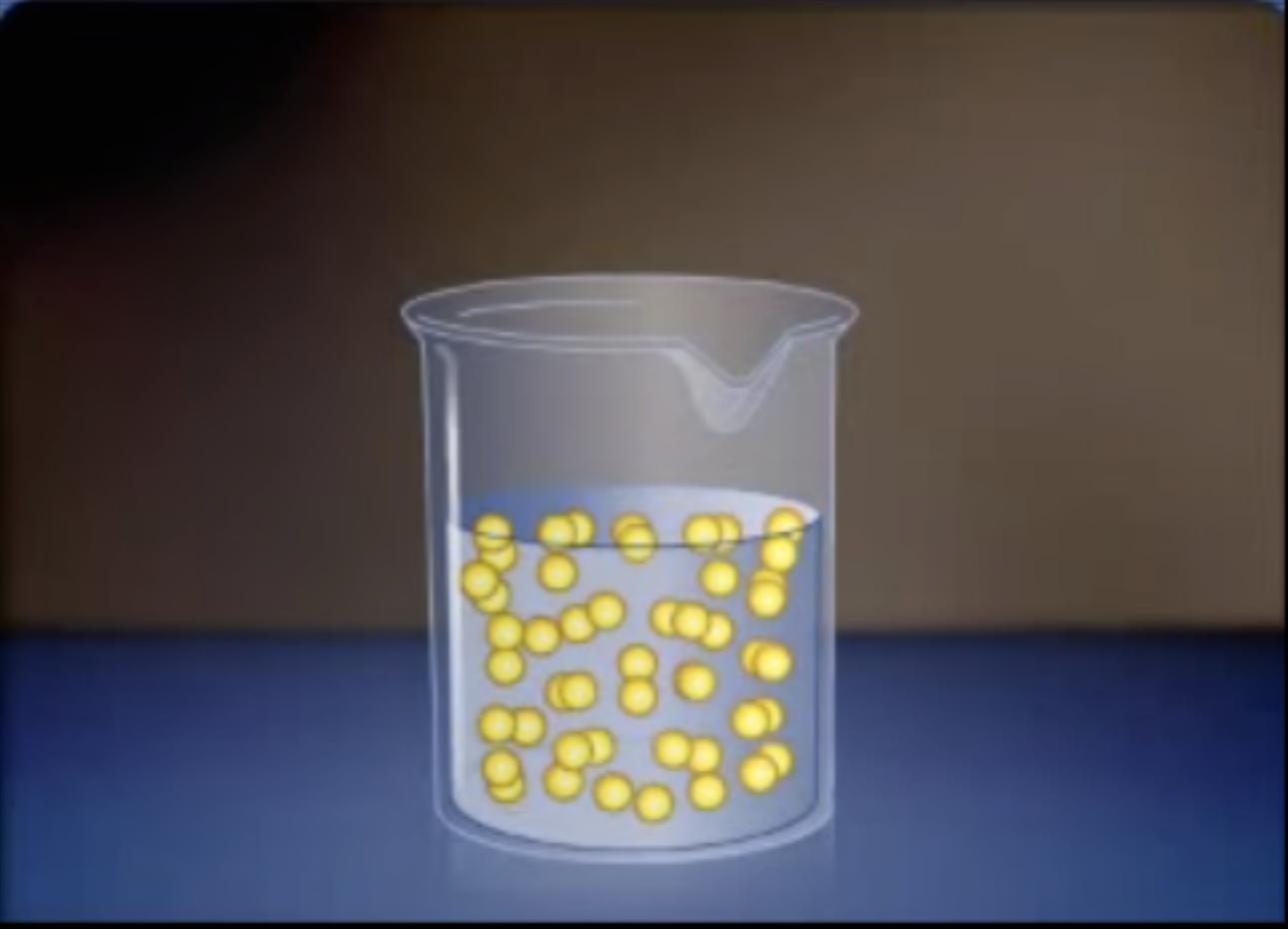
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Microscopic versus Macroscopic Brownian Motion



The video player shows a beaker containing a liquid with numerous small yellow spheres representing particles. The video is titled "How Diffusion Works" and is by John Munro. The video player interface includes a progress bar at 0:02 / 1:31, a volume icon, a CC icon, a settings gear, and a full screen icon. Below the video, the title "How Diffusion Works" is displayed, followed by the channel name "John Munro" and a "Subscribe" button with 1,210 subscribers. The view count "41,933" is shown in the bottom right corner.

How Diffusion Works

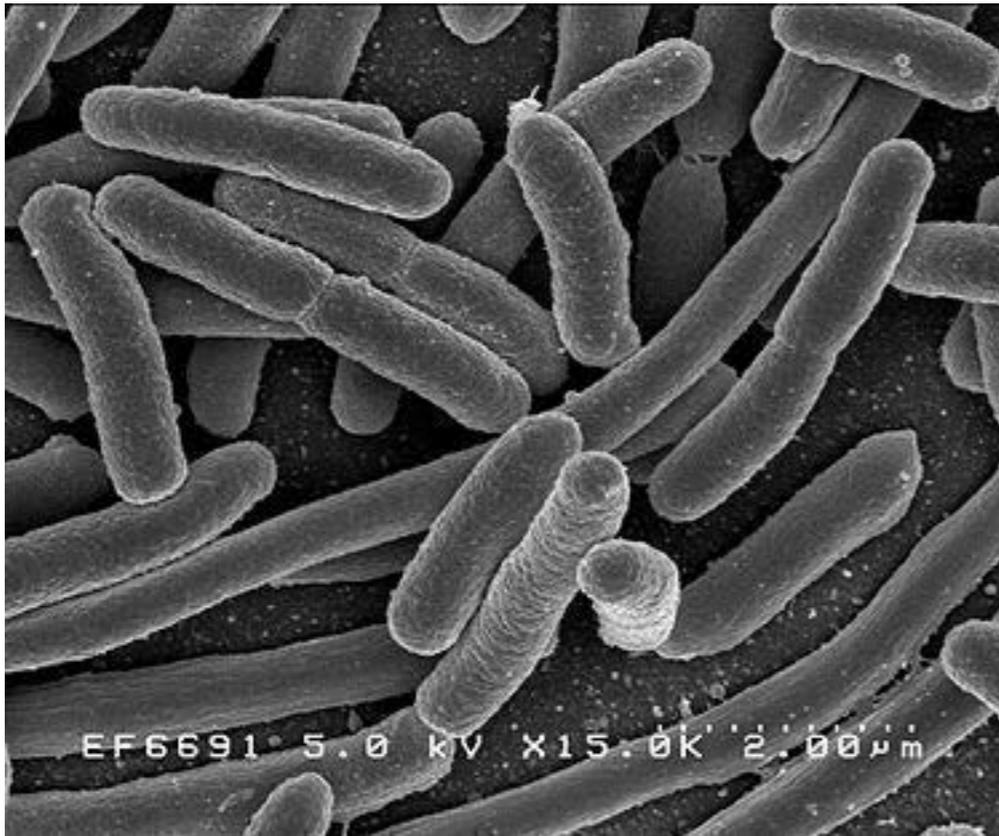
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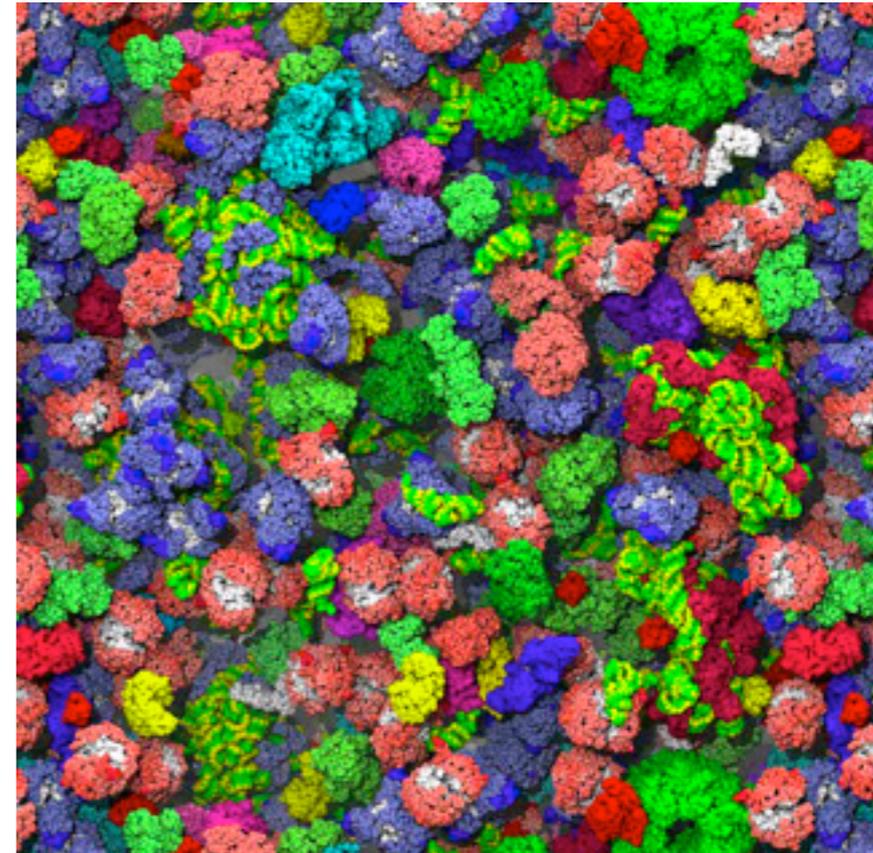
41,933

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Brownian Motion inside Cells



Courtesy of [Rocky Mountain Laboratories](#), NIAID, NIH; image in the public domain.



Courtesy of Sean R. McGuffee and Adrian H. Elcock. License: CC BY.

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?

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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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