



On Light and Life: a two-part story

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Part 1

Life
generating
Light

Part 2

Light
generating
Life



Part 1:
Bioluminescence in a
Unicellular Organism

Joseph Wright of Derby, 1771

bioluminescence

noun [U]

UK / ,baɪ.əʊ.luː.miˈnes.əns/

US / ,baɪ.oʊ.luː.məˈnes.əns/

light created by the body of a living creature, for example by some sea creatures and insects such as fireflies:

Cambridge Dictionary



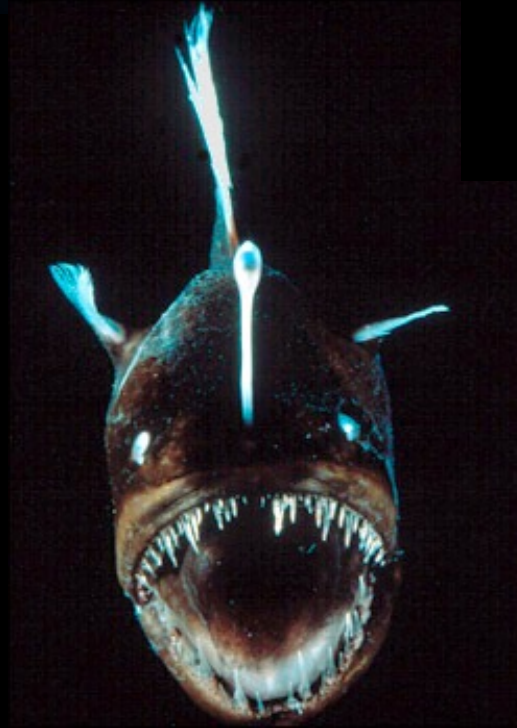
Cowfish, NG



Viper Fish , thespec



Sea Angels, Scuba Diving Resource



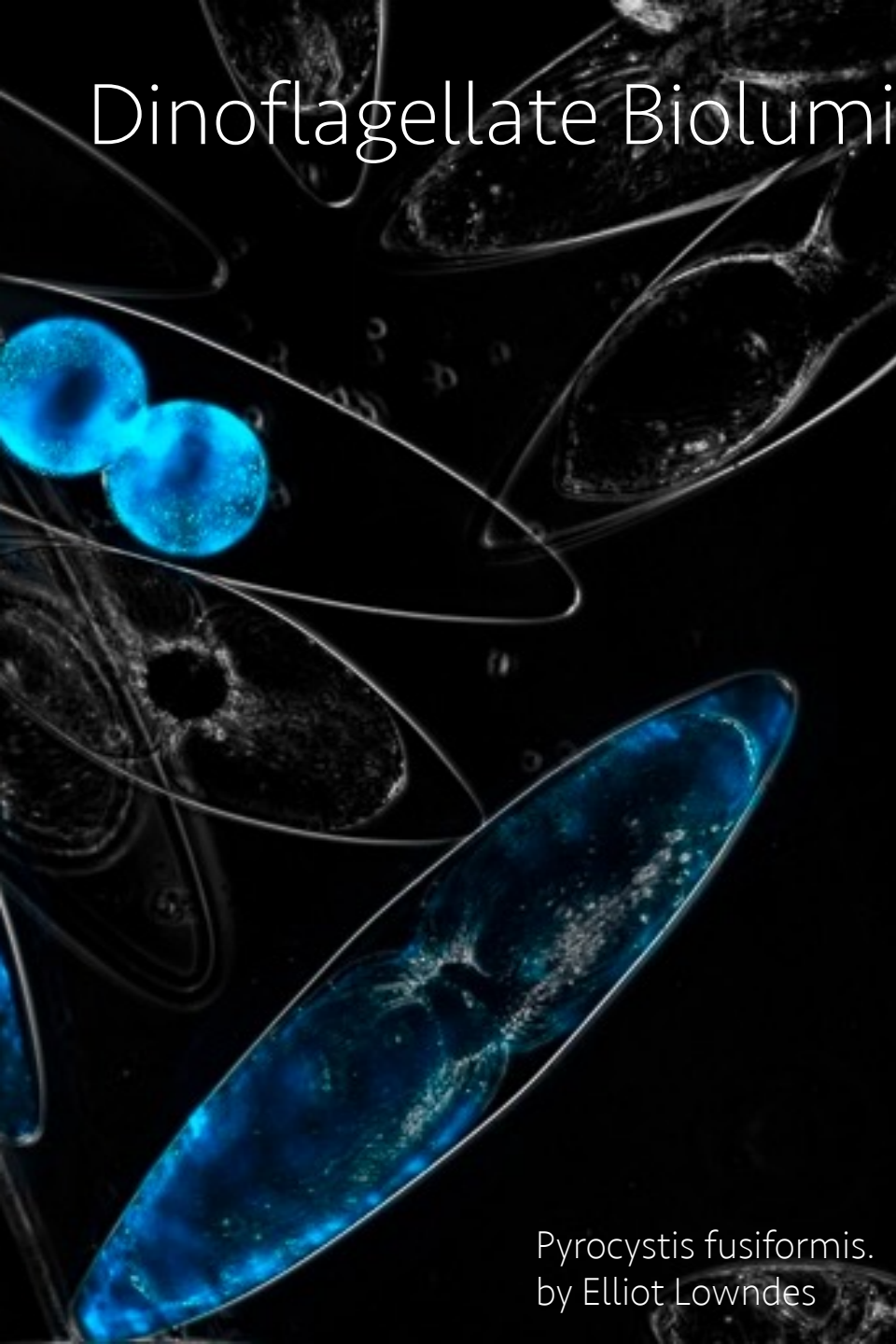
Anglerfish, alchetron

Glowing Blooms



video by David Finlay (adopted from THE Sun)

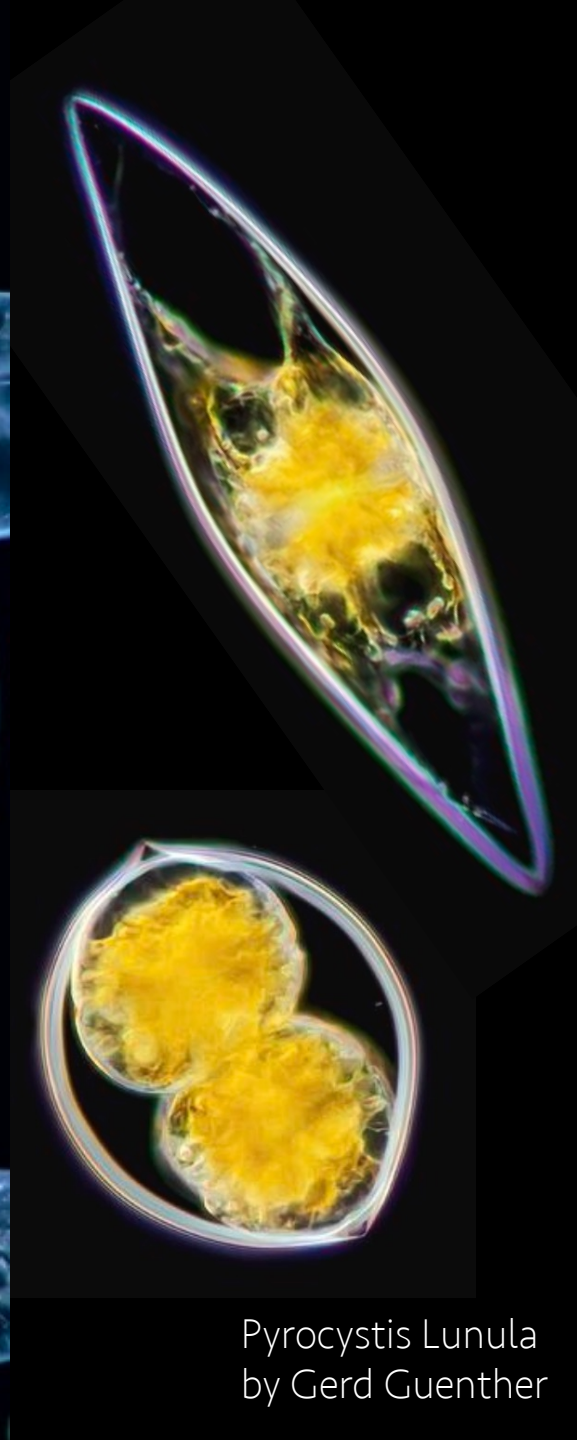
Dinoflagellate Bioluminescence



Pyrocystis fusiformis.
by Elliot Lowndes

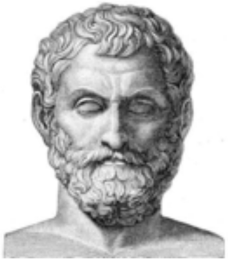


Noctiluca scintillans
by microbiologysociety



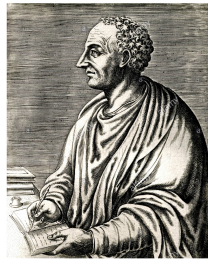
Pyrocystis Lunula
by Gerd Guenther

Bioluminescence in History: a 25-century Puzzle



Anaximenes of Miletus

“... the blade of his oar would sometimes be charged with a strange glowing ...”



Titus Livius

“... the shores were also luminous with frequent fires ...”



Ulisse Aldrovandi

“... kind of insect ... does not harm man when touched ... they have this [internal] light implanted from fire...”



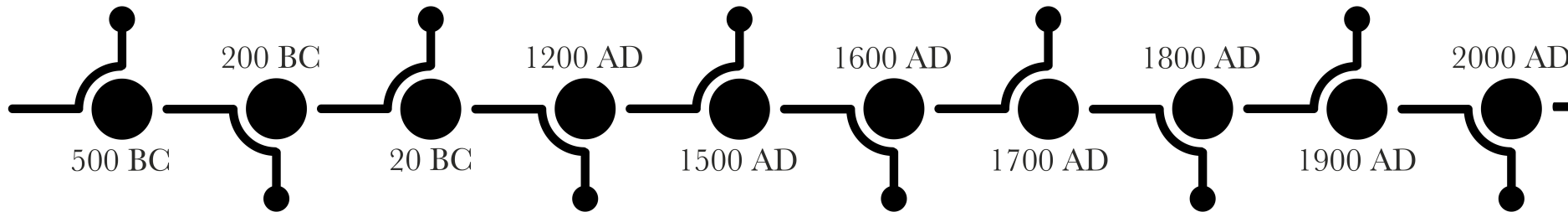
Isaac Newton

“... do not all bodies ... emit light as often as those parts are sufficiently agitated ... as for instance seawater in a ranging storm.”



Edmund Newton Harvey

“... I can state definitely that the luciferin ... is most likely a protein ... the proteins insoluble in water.”



Dongfang Shuo

“... if one travels on the sea, one may see fiery sparks when the water is stirred.”



Ibn-al-Baithar

“... Hobaheb, a beetle with wings that light up ...”



Robert Boyle

“... air was essential for light to be observed.”



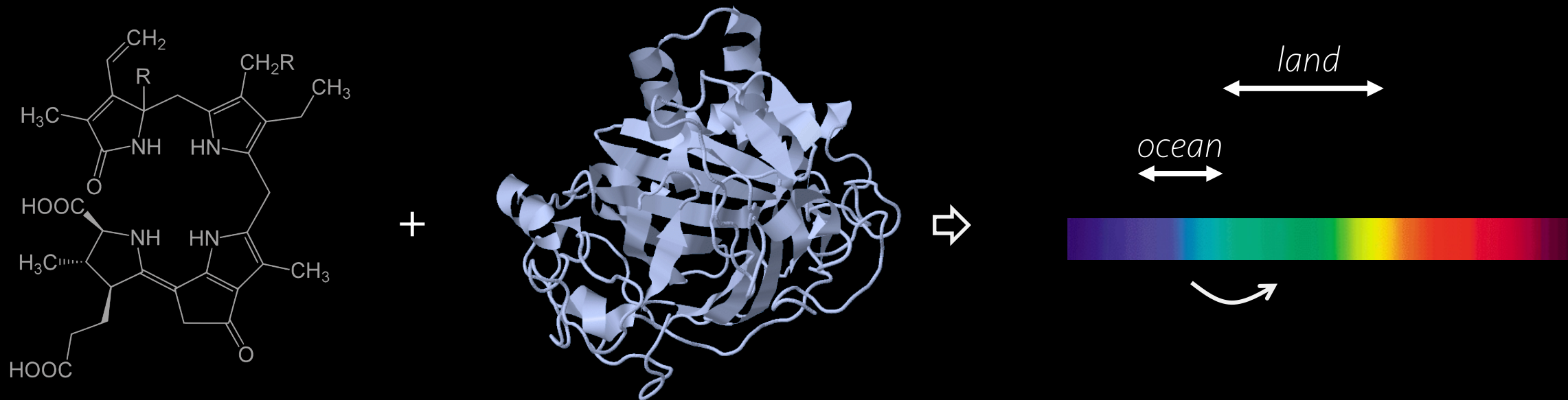
Charles Darwin

“... The vessel drove before her bows two billows of liquid phosphorus, and in her wake she was followed by a milky train. As far as the eye reached, the crest of every wave was bright, ...”

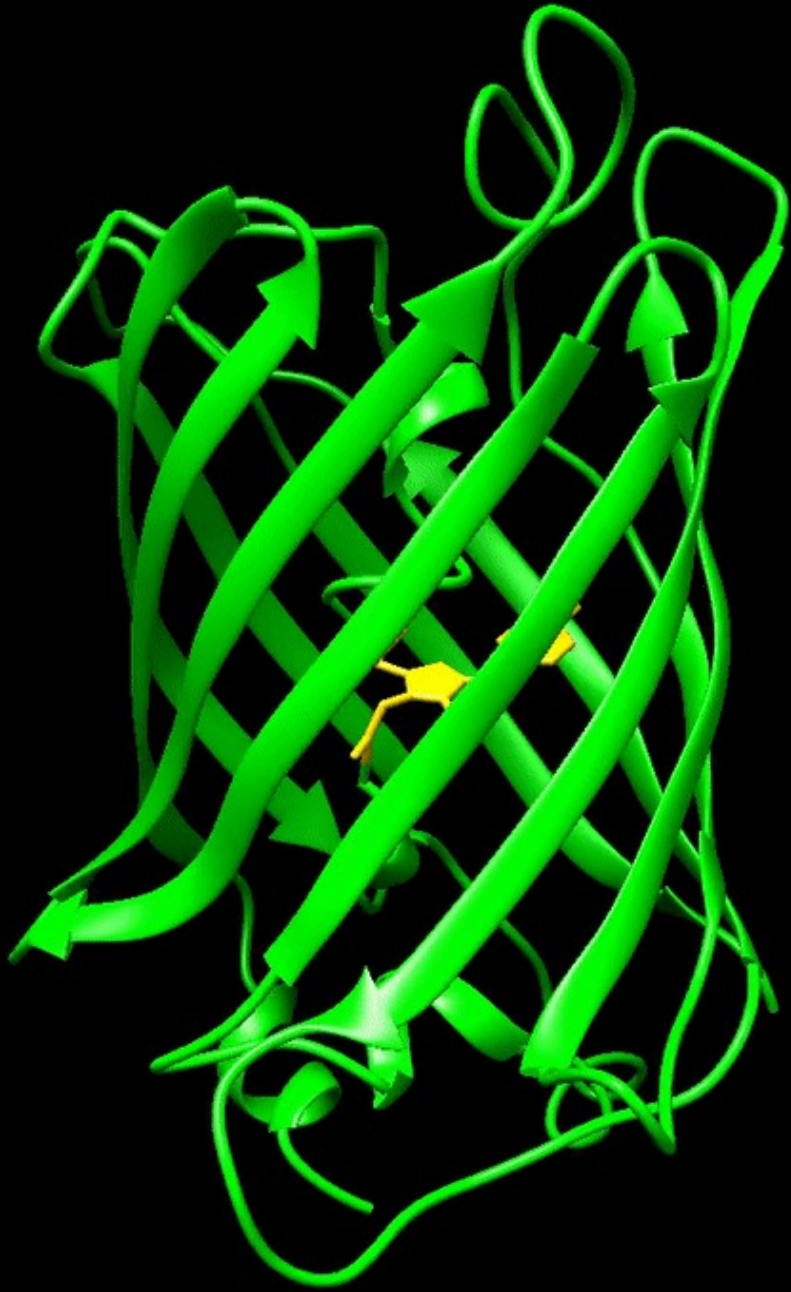


Osamu Shimomura, Martin Chalfie & Roger Y. Tsien
Noble Prize in Chemistry:

“for the discovery and development of the green fluorescent protein, GFP.”



Low pH + ATP + sometimes bounding protein



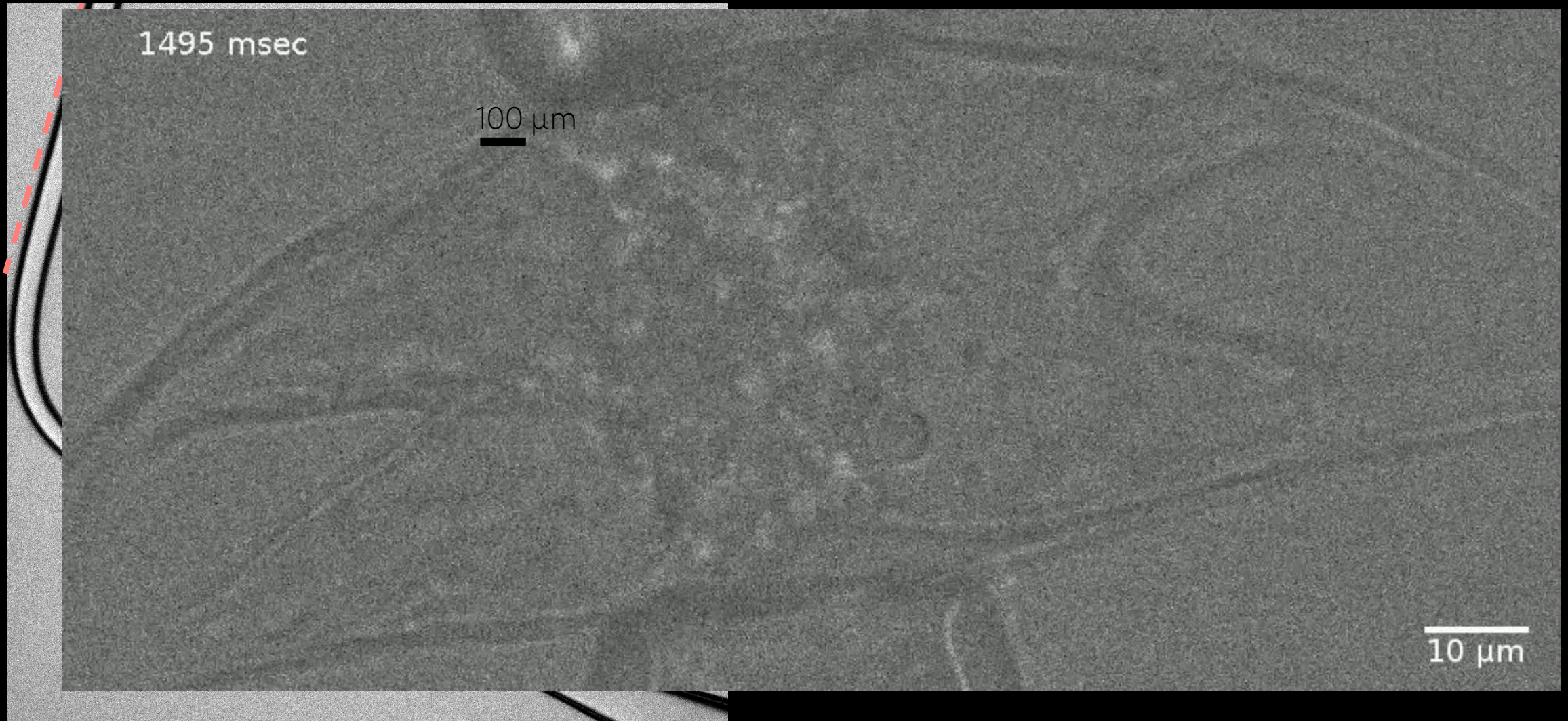
The Nobel Prize in Chemistry 2008 was awarded jointly to Osamu Shimomura, Martin Chalfie and Roger Y. Tsien "for the discovery and development of the green fluorescent protein, GFP."

we asked:

What triggers the bioluminescence ?

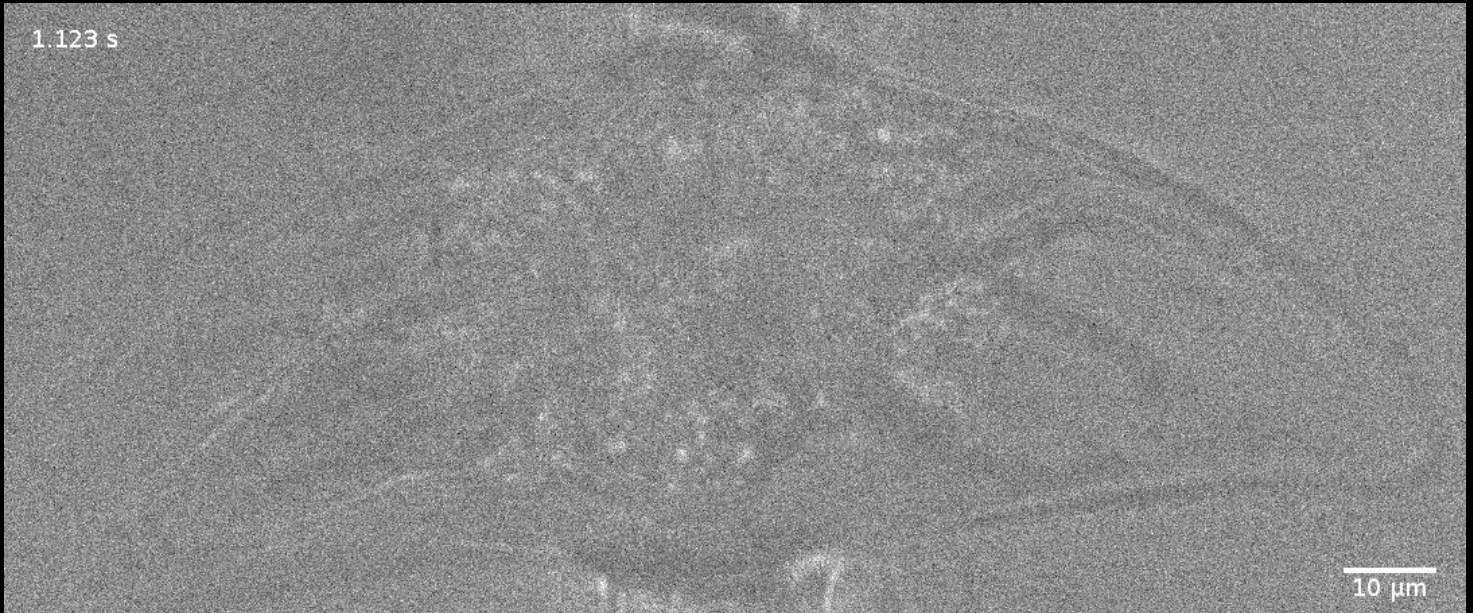
First Experiments on a Single Cell Level

P. Lunula as an Elastic body

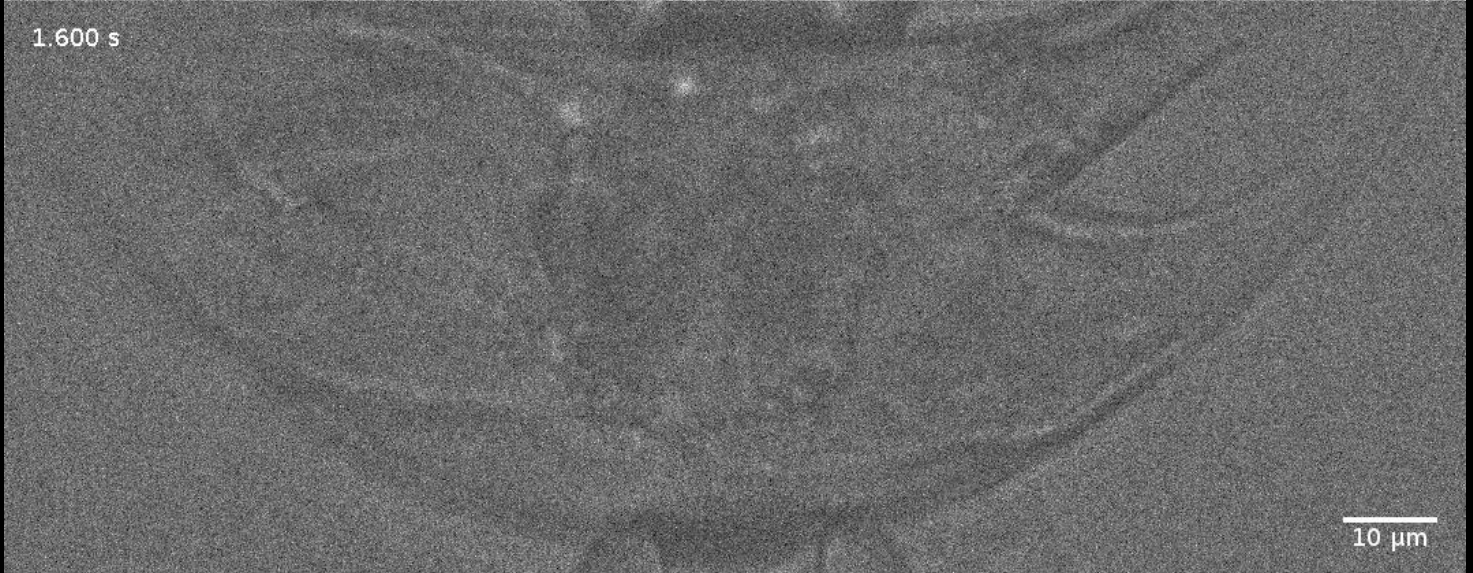


Stimulation Matters

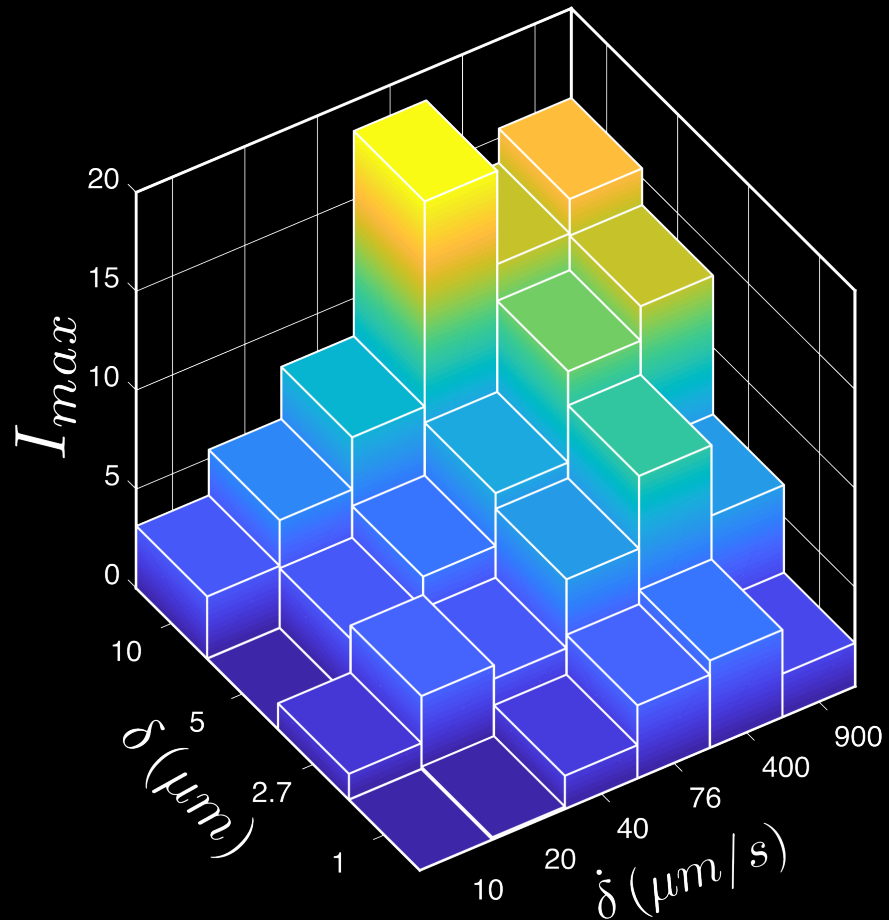
Fast but Small



Large but Slow



Experiments on a Single Cell Level



Nothing in Biology
Makes Sense Except
in the Light of Evolution

Essay by Theodosius Dobzhansky

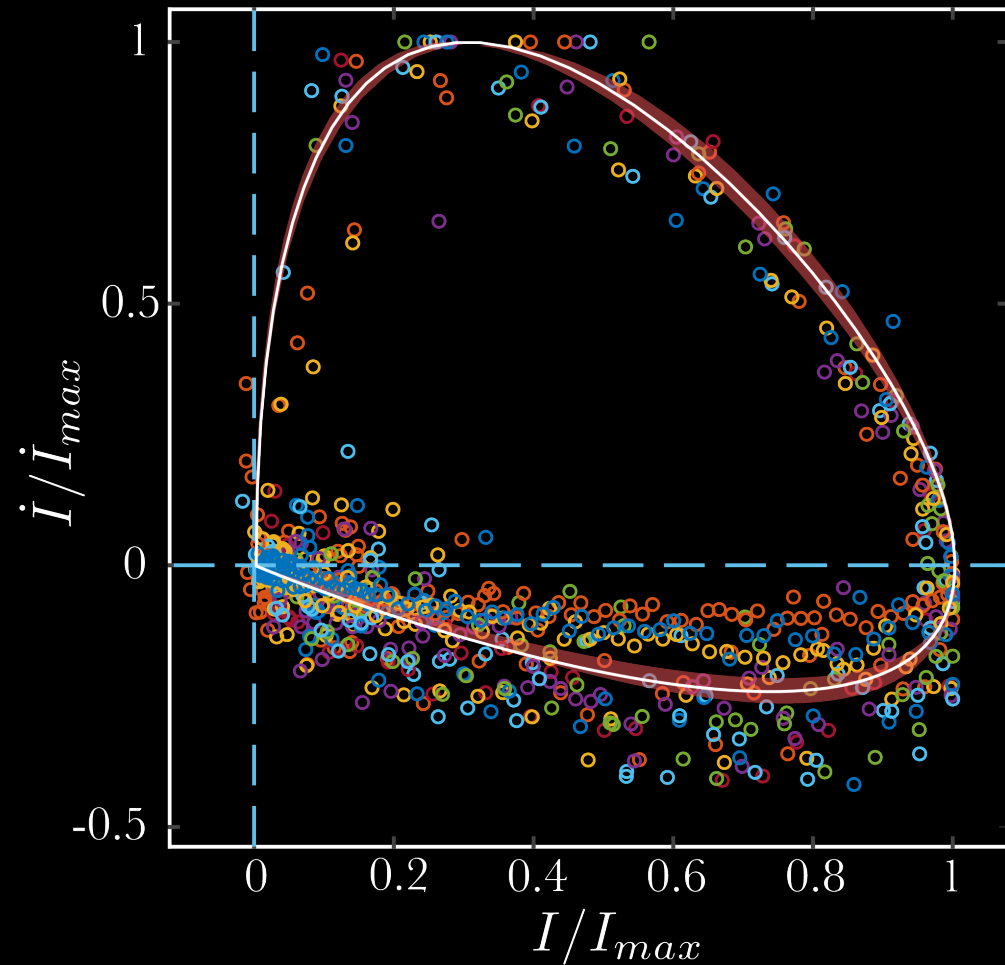
A Linear Dynamical System

$$\frac{d}{dt} \mathbf{x}(t) = \mathbf{A} \cdot \mathbf{x}(t) + \mathcal{N}(\mathbf{x}, t)$$

$$\mathbf{x} = [s, h, I] \quad \mathbf{A} = \begin{bmatrix} -\frac{1}{\tau_e} & 0 & 0 \\ \frac{1}{\tau_a} & -\frac{1}{\tau_a} & 0 \\ \frac{1}{\tau_r} & -\frac{1}{\tau_r} & -\frac{1}{\tau_r} \end{bmatrix} \quad \mathcal{N} = [\dot{\delta}/\mathcal{L}, 0, 0]$$

$$I = -\frac{\tau_a \dot{\delta} e^{-t/\tau_r} [\tau_a (e^{(1/\tau_r-1)t} - e^{(1/\tau_r-1/\tau_a)t}) - \tau_r (\tau_a (-e^{(1/\tau_r-1/\tau_a)t}) + e^{(1/\tau_r-1)t} + \tau_a - 1)]}{(\tau_r - 1)(\tau_a - 1)(\tau_r - \tau_a)}$$

Model

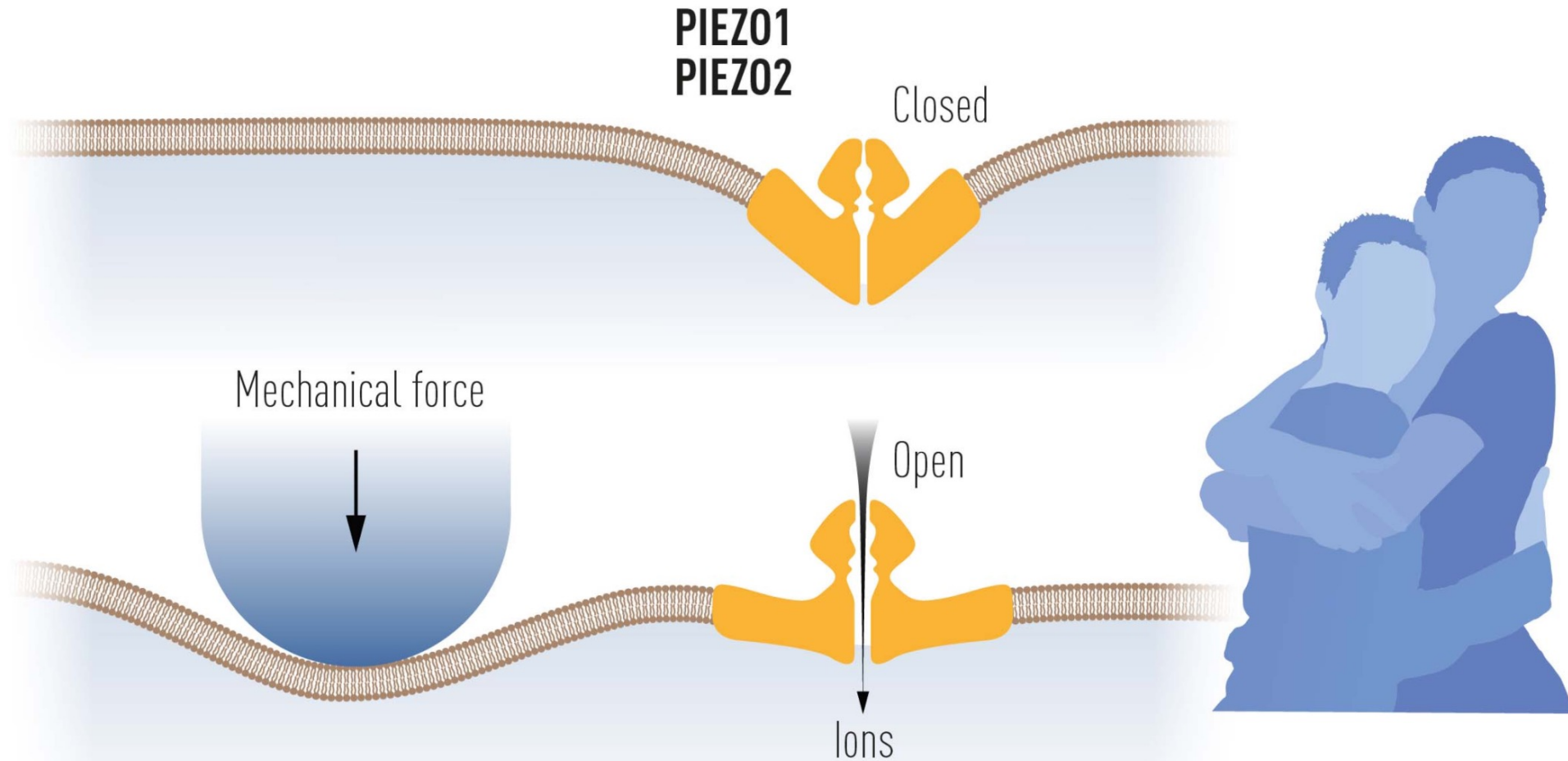


Bioluminescence Constant Matrix

$$\mathbf{A} = \begin{bmatrix} -33 & 0 & 0 \\ 5 & -5 & 0 \\ 100 & -100 & -100 \end{bmatrix}$$

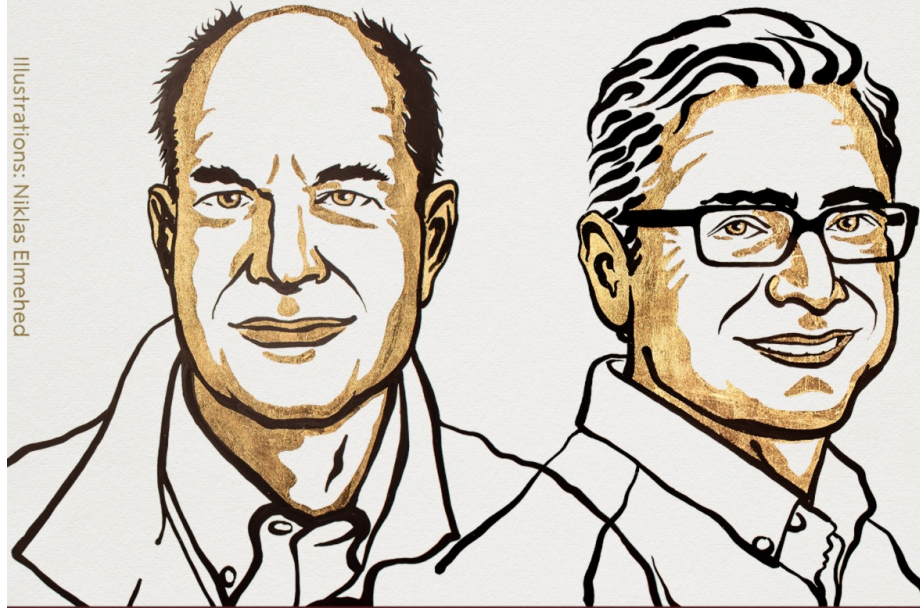
Evolutionary Biology in numbers!

Mechanobiology: Beyond Bioluminescence



THE NOBEL PRIZE
IN PHYSIOLOGY OR MEDICINE 2021

Illustrations: Niklas Elmehed



David Julius

Ardem Patapoutian

“for their discoveries of receptors
for temperature and touch”

THE NOBEL ASSEMBLY AT KAROLINSKA INSTITUTET

Team



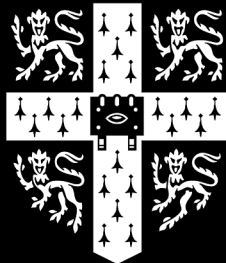
Nico Schramma



Sophie Beck



Cintia Perugaci



Hélène
de Maleprade



Christophe
Raufaste



Eric Lauga



Ray Goldstein



Thank you!

visit us!



@maziyarj

fluidlab.nl