

Modelling scientific laws: ***From putative generalisations to nomological characterisation***

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Principled Mechanistic (PM) explanations

Mechanistic explanations

+

Lawlike generalisations

Very few, if any, established laws in cell biology

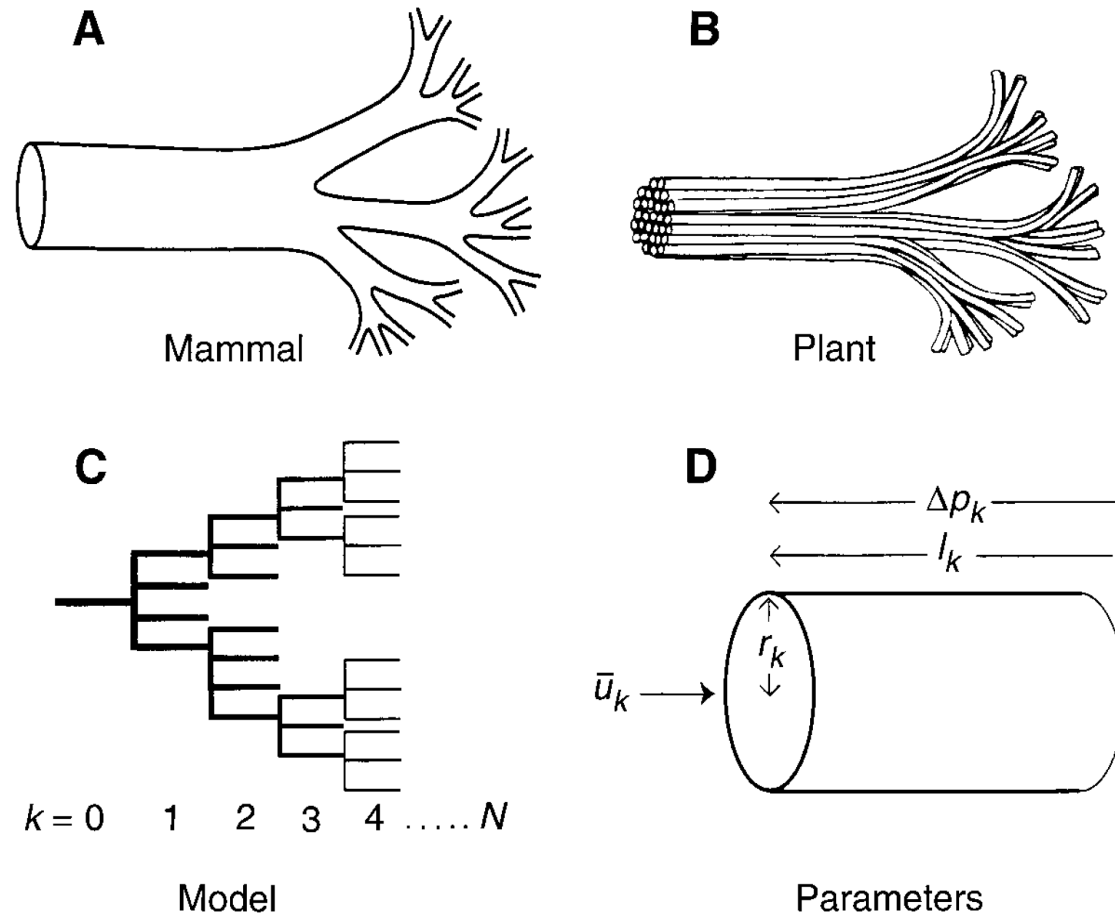
From modelling parts to modelling laws

- **Molecules** Physical artefacts / simulations
- **Mechanisms** Often: mental maps / diagrams
- **Putative laws** How do we model them at the outset?

A three-component approach

- **Examination** Artefactual models, where feasible
 - A putative cell-biological law can, if scientifically feasible, be examined using artefactual models, among other means.
- **Characterisation** Possible basis / consequences
 - Such modelling could roughly be thought of as characterising the possible basis of the law or characterising its consequences (with potential overlap).
- **Comparison** Assessing progress across putative laws
 - A Giambattista Vico-inspired ‘factum’—‘certum’—‘verum’ framework could be used to assess the modelling progress of different putative laws relative to each other.

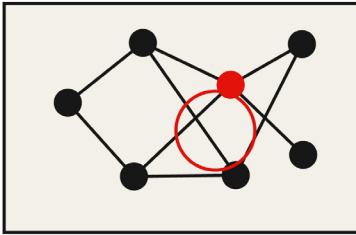
Modelling allometric scaling laws in biology



Modelling a putative generalisation

Model a Possible Basis

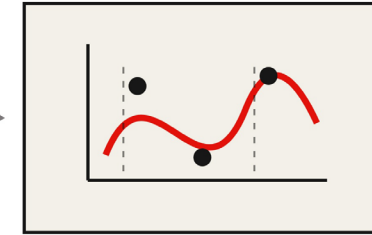
Can it be generated?



PUTATIVE GENERALISATION

Model Consequences

What follows?



VARY MODELS & SYSTEMS · COMPARE WITH EVIDENCE

Profile



ASSESS AS

PRINCIPLE

LAW(S)

PRINCIPLE + LAW(S)

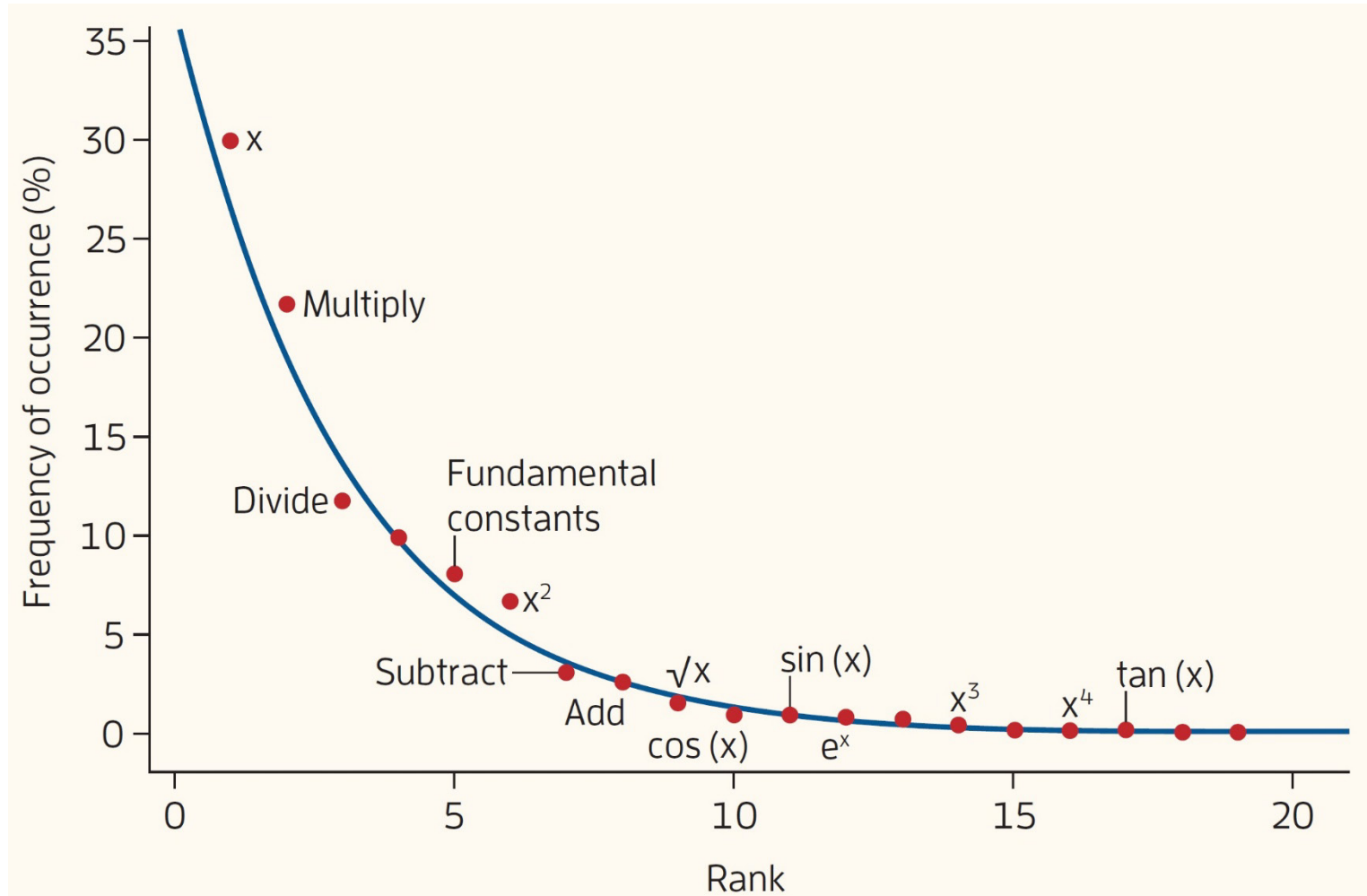
REVISE / REJECT

A Vico-inspired framework

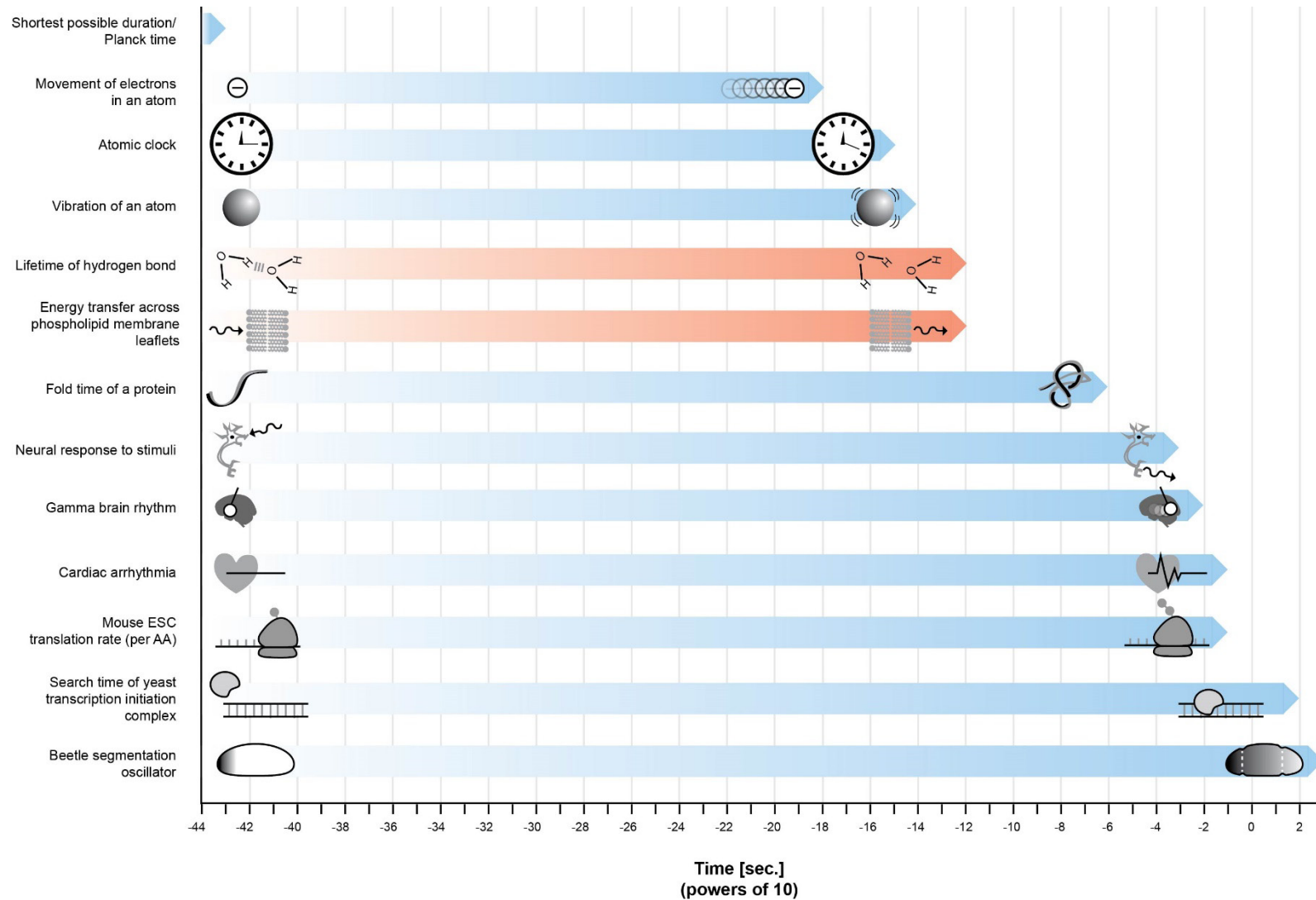
Comparing modelling progress across putative laws

- ***factum*** Informal / formal formulation
- ***certum*** Empirical evidence for the generalisation
- ***verum*** Regularities it could capture or explain

Frequency of symbols & operators in physics formulas

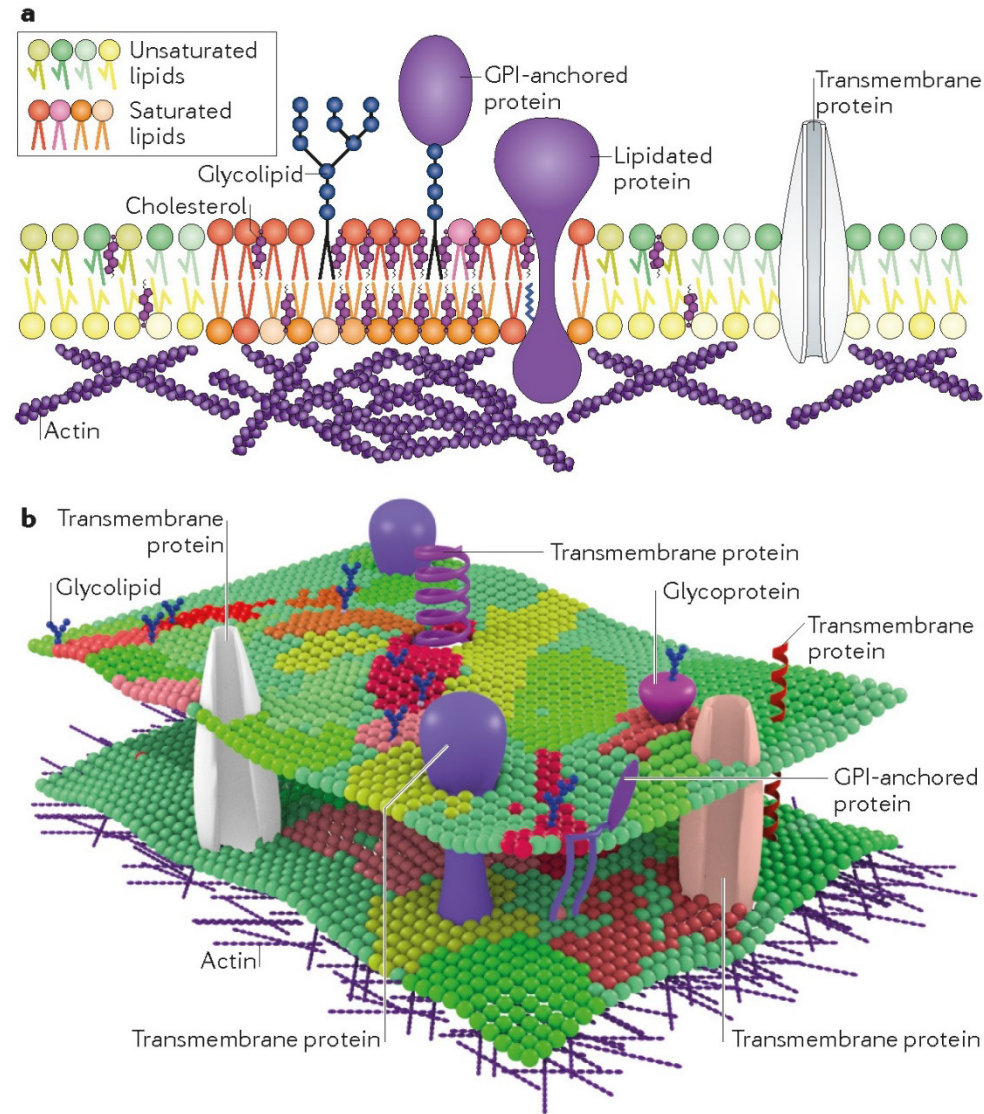


Timekeeping at the cellular level



Ehsani, *arXiv* 2012

The plasma membrane



Sezgin *et al.*
*Nature Reviews Molecular
Cell Biology* 2017

Principle of cellular synchrony

The principle would entail that all processes within a cell (e.g. the activity of proteins, intracellular transport, DNA transcription, etc.) happen in a synchronised manner and are cyclically coordinated based on a sub-second vibrational frequency.

This might further entail that unsynchronised processes may lead to cell death.

Modelling the principle of cellular synchrony

Self-sustained oscillators

Each metronome is an autonomous oscillator with its own natural frequency.

Movable membrane (common support)

The platform moves in response to the forces exerted by the oscillators and couples them reciprocally.

Mechanical isolation

Low-friction bearings allow horizontal motion in the plane.

External drive (optional)

A shaker can drive the platform to act as an active pacemaker.

Tunable properties

Mass, stiffness and damping of the platform can be adjusted.

