

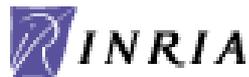
Les prix Nobel de Physique et de Chimie 2024

Jean-Paul Haton

LORIA/INRIA - Université de Lorraine
Institut Universitaire de France



Mercredi 11 décembre 2024



Prix Nobel de Physique 2024

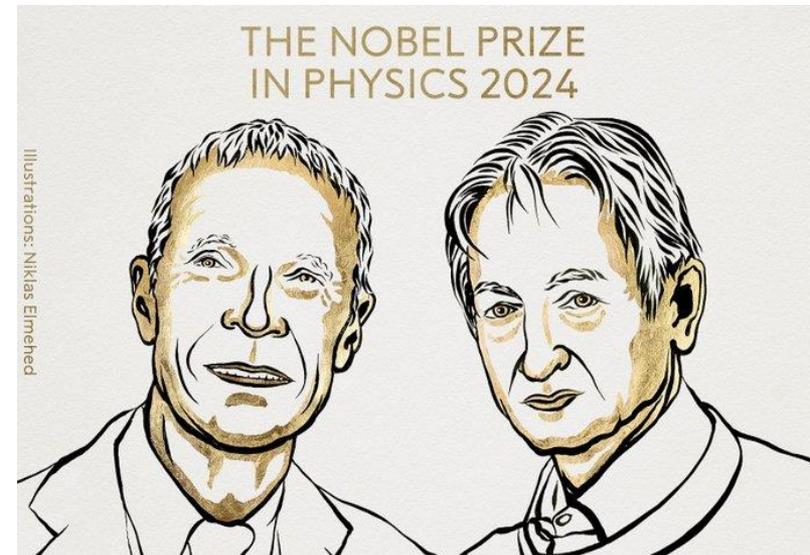
The Royal Swedish Academy of Sciences has decided to award the
Nobel Prize in Physics 2024 to

JOHN J. HOPFIELD

Born 1933 in Chicago, IL, USA. PhD 1958 from Cornell University, USA. Professor at Princeton University, NJ, USA.

GEOFFREY E. HINTON (prix Turing 2019 avec Yann Le Cun et Yoshua Bengio)

Born 1947 in London. PhD 1978 from The University of Edinburgh, UK. Professor at University of Toronto, Canada.



“for foundational discoveries and inventions that enable machine learning with artificial neural networks”

Proc. Natl. Acad. Sci. USA
Vol. 79, pp. 2554–2558, April 1982
Biophysics

Neural networks and physical systems with emergent collective computational abilities

(associative memory/parallel processing/categorization/content-addressable memory/fail-soft devices)

J. J. HOPFIELD

Division of Chemistry and Biology, California Institute of Technology, Pasadena, California 91125; and Bell Laboratories, Murray Hill, New Jersey 07974

Jean-Paul Haton “Neural Networks for automatic speech recognition “ In *Fuzzy Logic and Neural Network Handbook*, McGraw Hill, 1996.

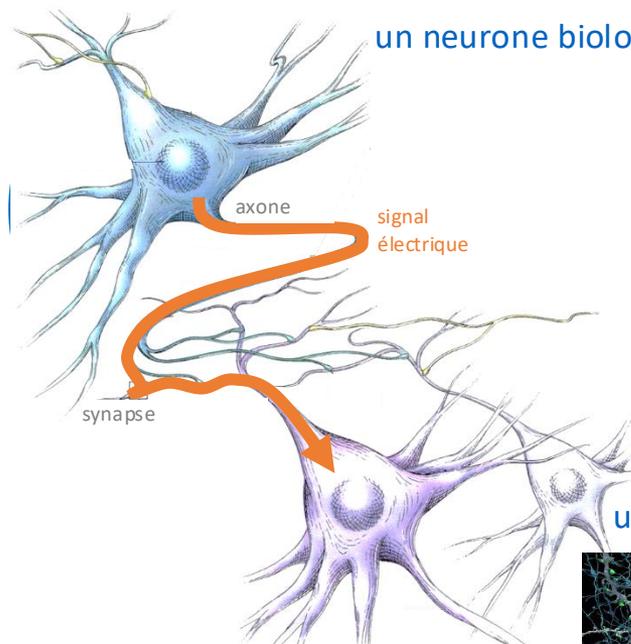
2.1 Basic Principles

ANN research started in the 1940s with the pioneering work of **McCulloch and Pitts** on the formal neuron.

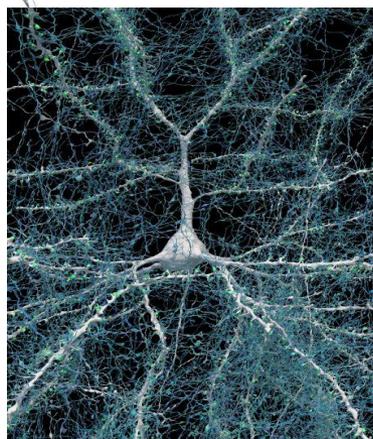
A second important milestone was the perceptron of **Rosenblatt** in the early 1960s. There was then a dramatic decrease in research effort, especially after a paper by Minsky and Papert showing the limitations of the perceptron. ANNs have finally received important renewed interest in the 1980s with **Hopfield's** approach and the backpropagation learning algorithm.

IA connexionniste: la machine qui "imite" la nature

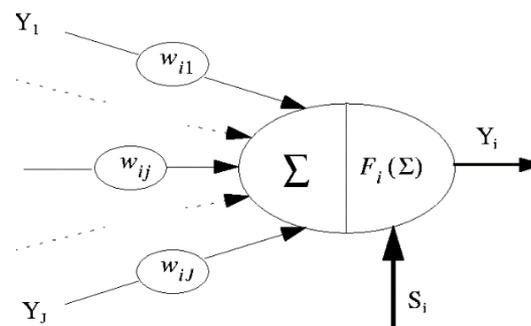
un neurone biologique



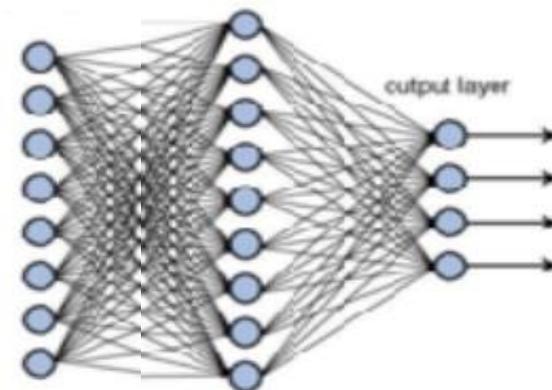
un réseau neuronal



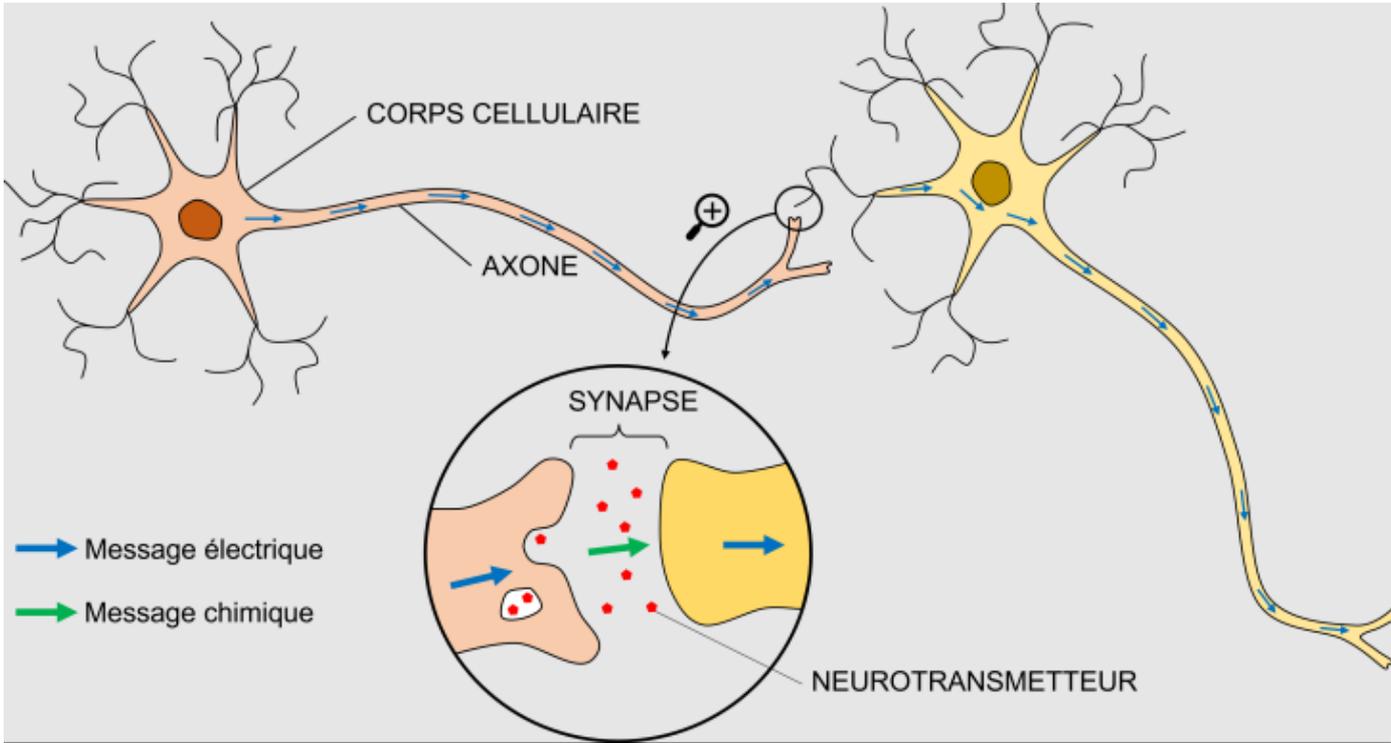
un neurone formel (McCulloch et Pitts 1943)



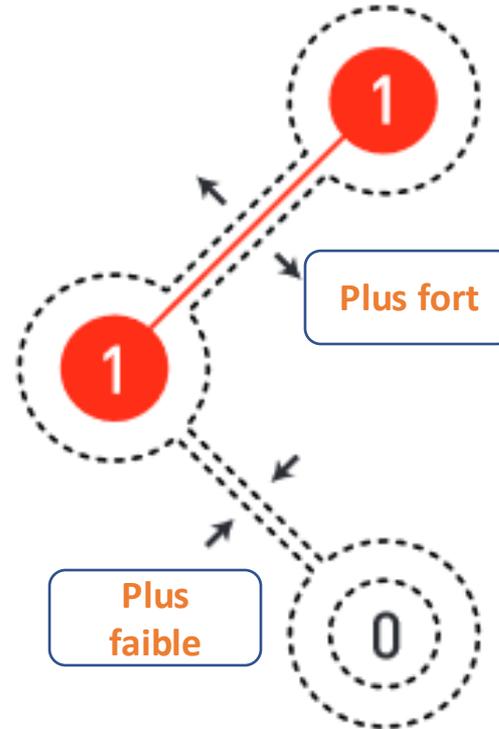
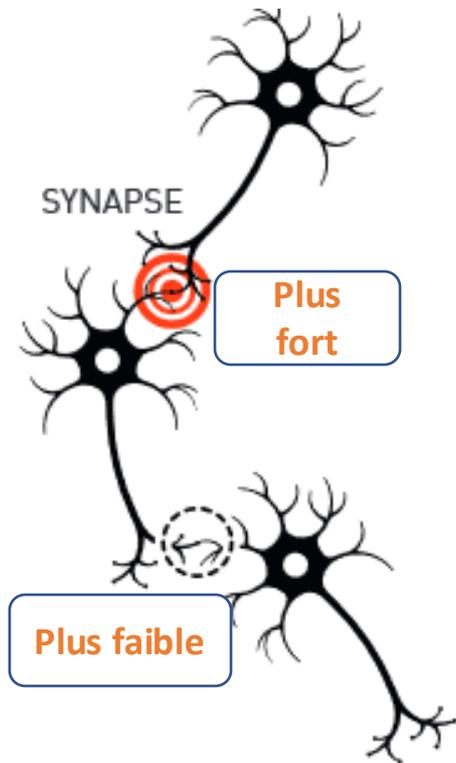
un réseau neuromimétique



Communication inter-neuronale

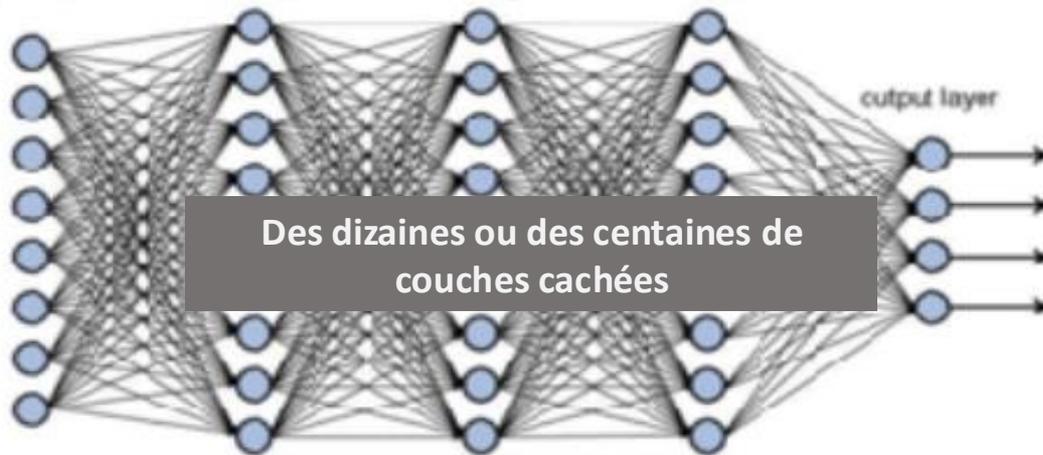


Apprentissage



L'ère des données

Avancée récente décisive : réseaux « profonds » et les algorithmes d'apprentissage associés : *deep learning*.



3 facteurs concomitants :

- La technologie (loi de Moore, NVIDIA)
- L'algorithmique
- Les données (*Big data*)

Prix Nobel de Chimie 2024

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2024 with one half to

David Baker (1962, USA)

University of Washington, Seattle, WA,
USA Howard Hughes Medical Institute, USA
“for computational protein design”

and the other half jointly to

Demis Hassabis (1976, GB)

Google DeepMind, London, UK

John Jumper (1985, USA)

Google DeepMind, London, UK

“for protein structure prediction”



Protéines

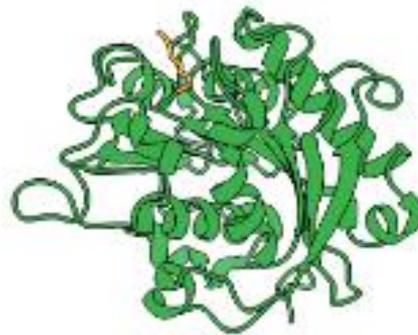
- Chaînes d'acides aminés qui se replient sur elles-mêmes
- La forme 3D est codée dans la séquence d'acides aminés
- D'où deux défis :
 - **Prédire la structure 3D** à partir d'une séquence d'acides : *AlphaFold*

Structures de protéines

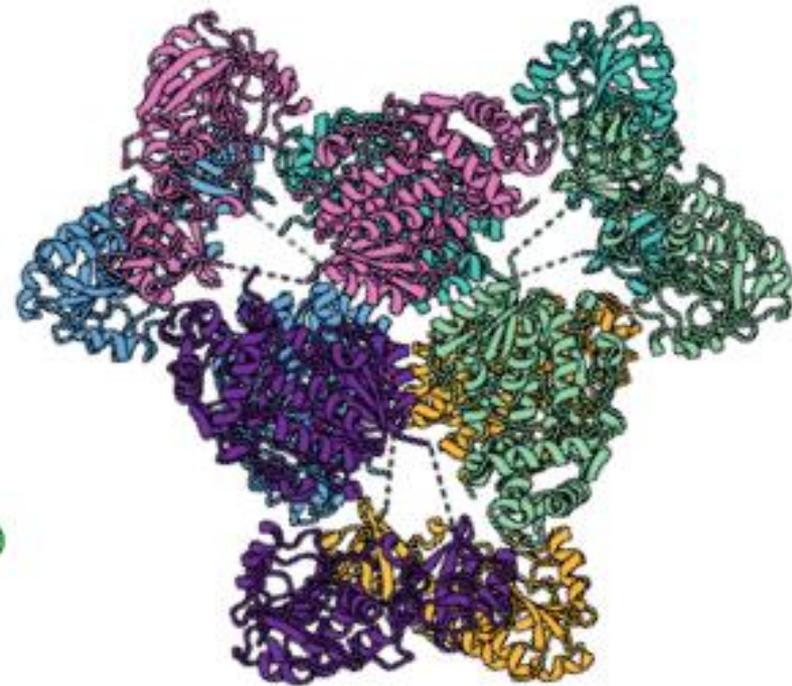
(AlphaFold2 a prédit les formes de plus de 350 000 protéines et fourni une carte des protéines)



2022: Part of a huge molecular structure in the human body. More than a thousand proteins form a pore through the membrane surrounding the cell nucleus.



2022: Natural enzymes that can decompose plastic. The aim is to design proteins that can be used to recycle plastic.

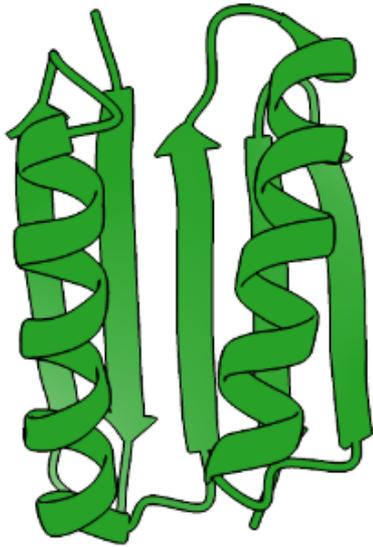


2023: A bacterial enzyme that causes antibiotic resistance. The structure is important for discovering ways of preventing antibiotic resistance.

Protéines

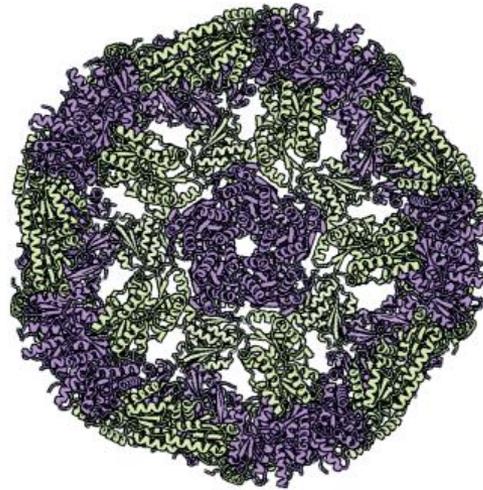
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 - **Concevoir la nouvelle protéine** à structure 3D donnée : *Rosetta*

Les protéines inédites de D. Baker (programme Rosetta)

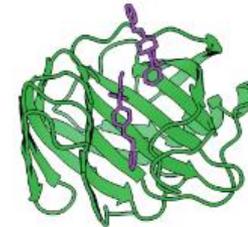


Top 7

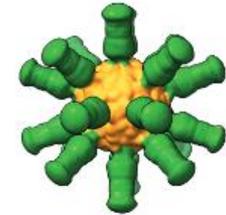
Première protéine *de novo* (2003)



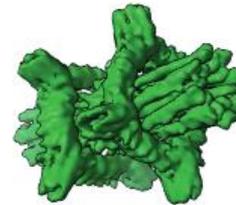
2016: New nanomaterials where up to 120 proteins spontaneously link together.



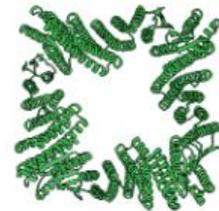
2017: Proteins that bind to an opioid called fentanyl (purple). These could be used to detect fentanyl in the environment.



2021: Nanoparticles (yellow) with proteins imitating influenza virus on the surface (green) that can be used as a vaccine for influenza. Successful in animal models.



2022: Proteins that function as a type of molecular rotor.



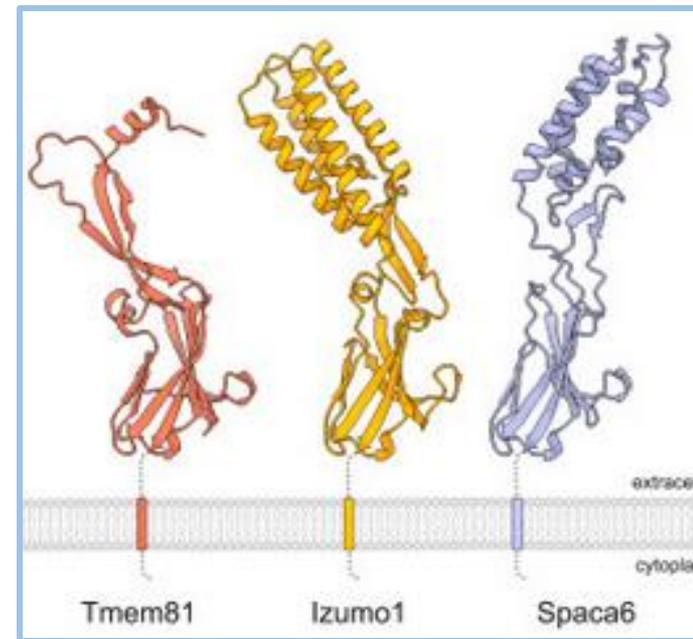
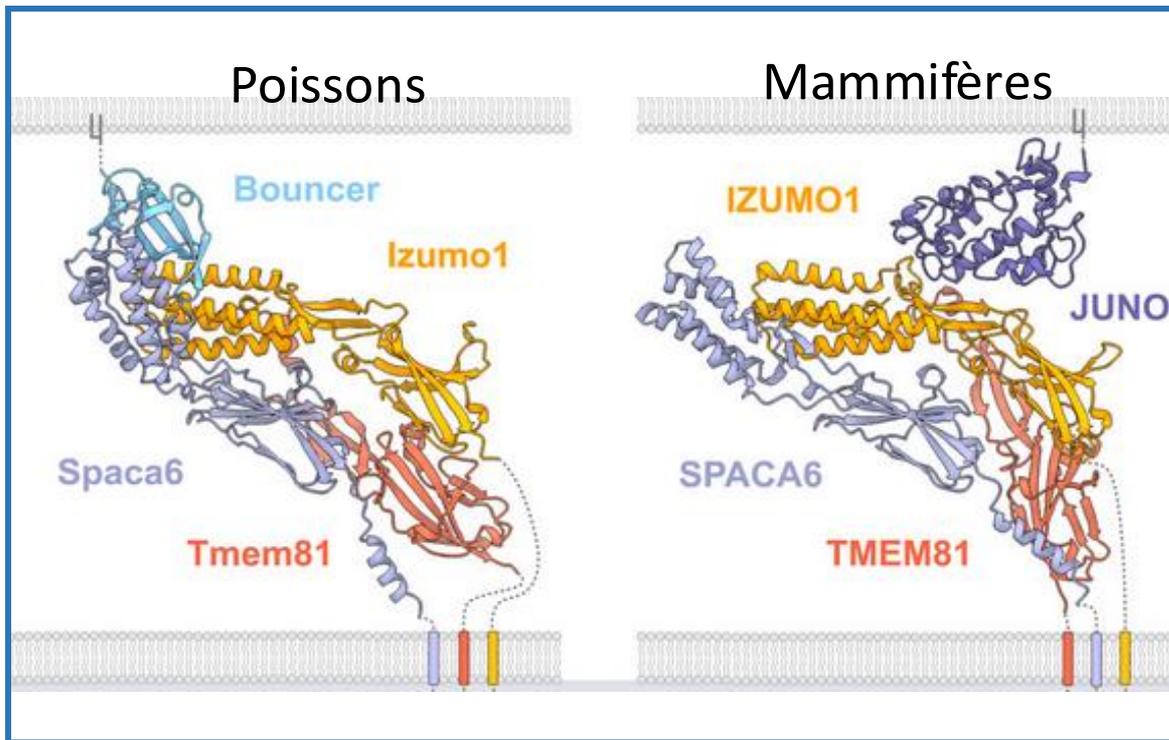
2024: Geometrically shaped proteins that can change their shape due to external influences. Could be used for producing tiny sensors.

Protéines

- Chaînes d'acides aminés qui se replient sur elles-mêmes
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 - **Prédire la structure 3D** à partir d'une séquence d'acides : ***AlphaFold***
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Un prix Nobel de chimie à la croisée de la biologie et de l'IA...!

AlphaFold et la fécondation...(nov. 2024)



Protéine Tmem81 : lien entre le spermatozoïde et l'ovule.
Poisson, souris, être humain... : même recette!!

Prix Nobel d'Économie 2024

“for studies of how institutions are formed and affect prosperity”

Daron Acemoglu

“for studies of how institutions are formed and affect prosperity”



Daron Acemoglu. Ill. Niklas Elmehed © Nobel Prize Outreach

Simon Johnson

“for studies of how institutions are formed and affect prosperity”



Simon Johnson. Ill. Niklas Elmehed © Nobel Prize Outreach

James Robinson

“for studies of how institutions are formed and affect prosperity”



James Robinson. Ill. Niklas Elmehed © Nobel Prize Outreach

Impact des technologies sur nos vies...
dont l'IA!!

Merci !

