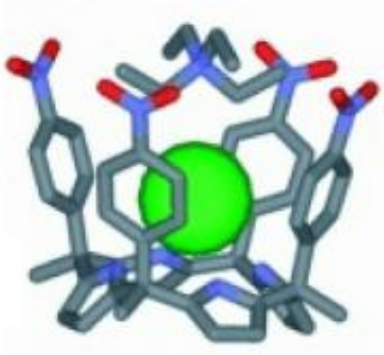
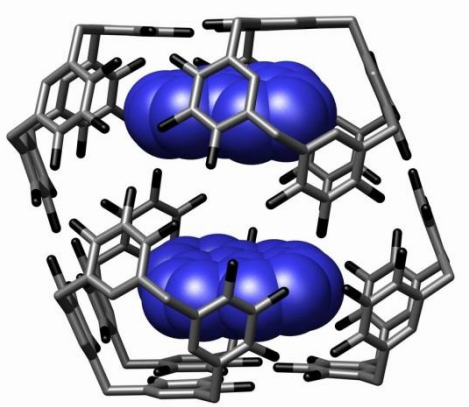


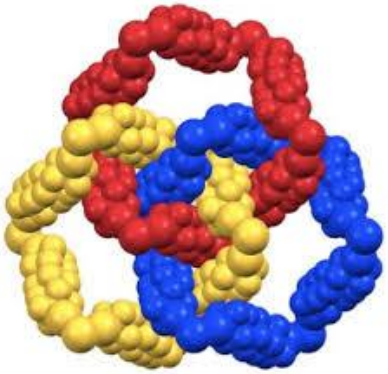


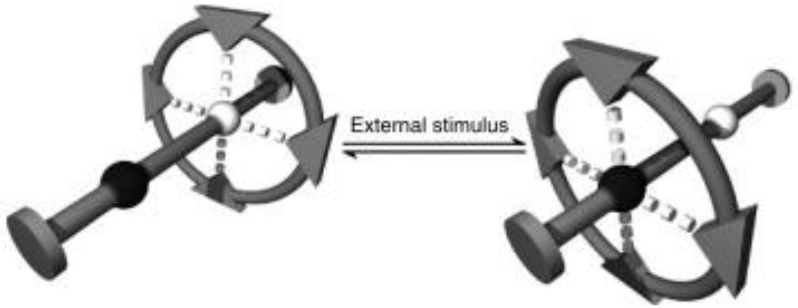
Supramolecular Chemistry

6 CFU - Master Degree in Chemistry @Units

AA 2026/2027

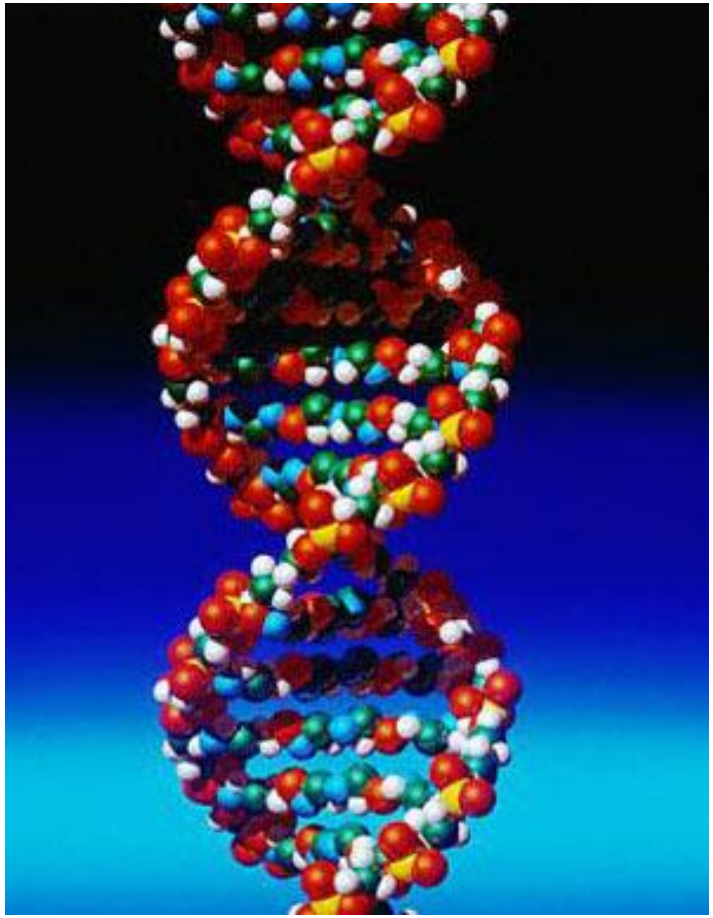
Prof. Elisabetta Iengo
eiengo@units.it

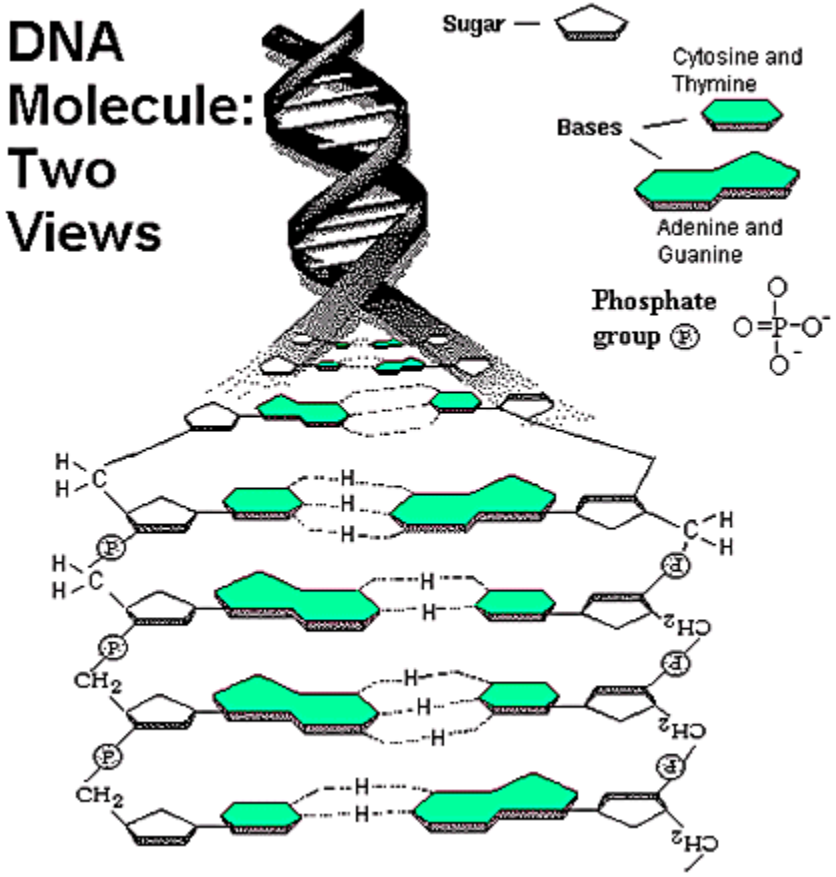




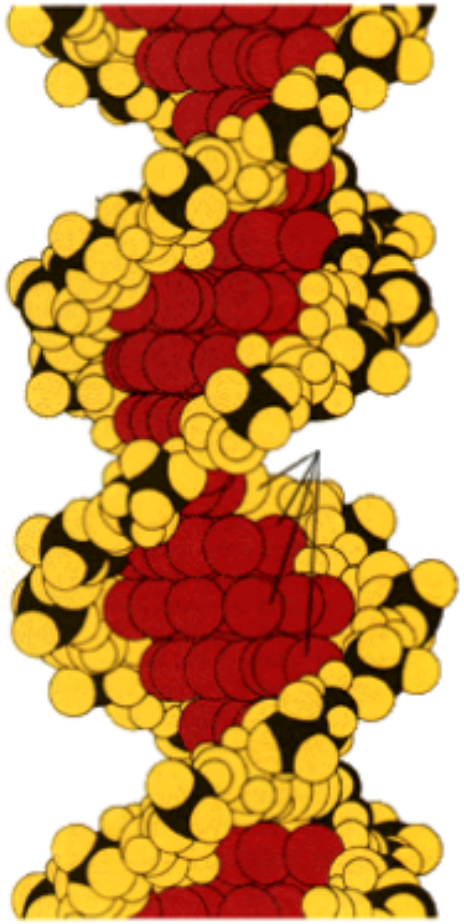
The original inspiration: Supramolecular systems in Nature

DNA





Information Storage



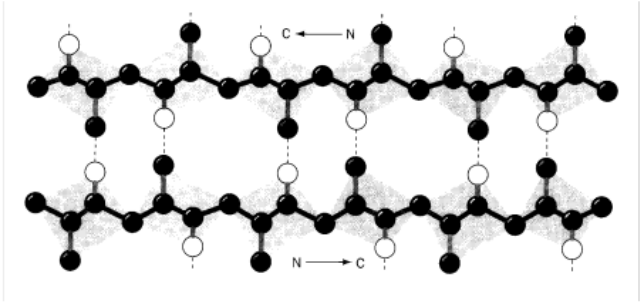
Watson & Crick 1953

The ultimate supramolecular material?

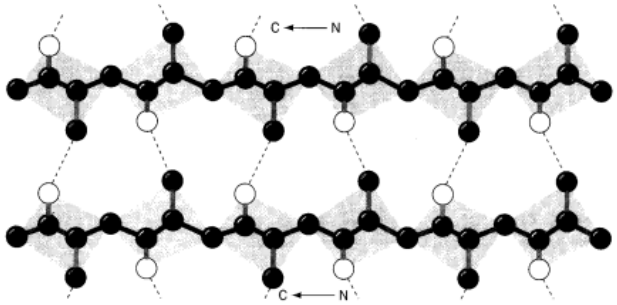
- Encodes gigabytes of data
- Can Self-Replicate
- Built-in Error Correction
- Is the basis of life

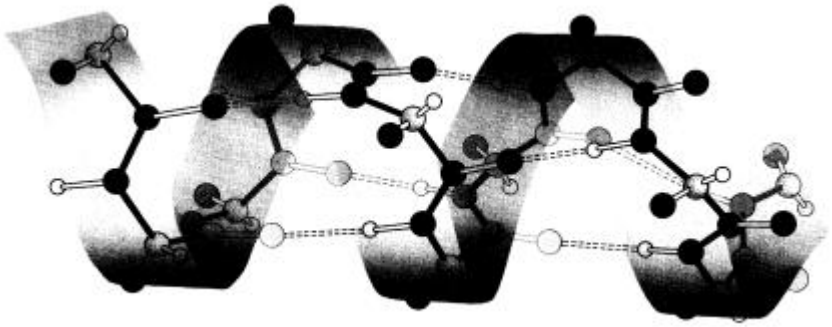
The original inspiration: Supramolecular systems in Nature

PROTEINS



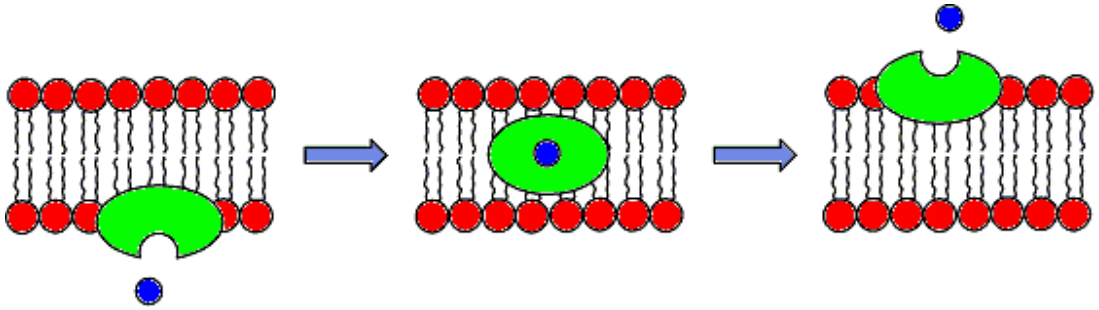
(a)

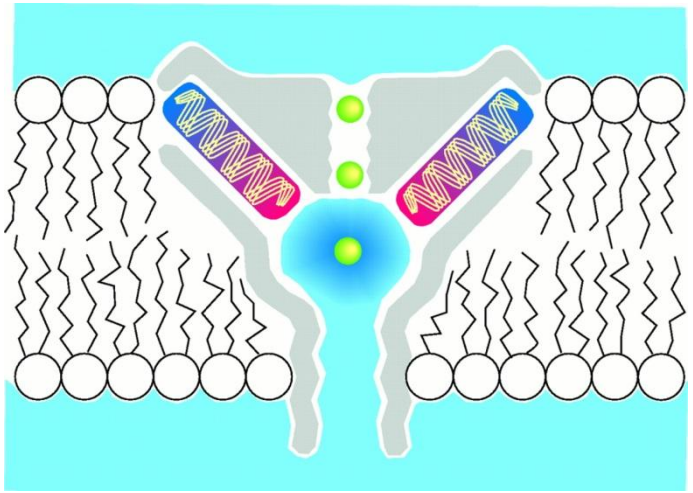




The original inspiration: Supramolecular systems in Nature

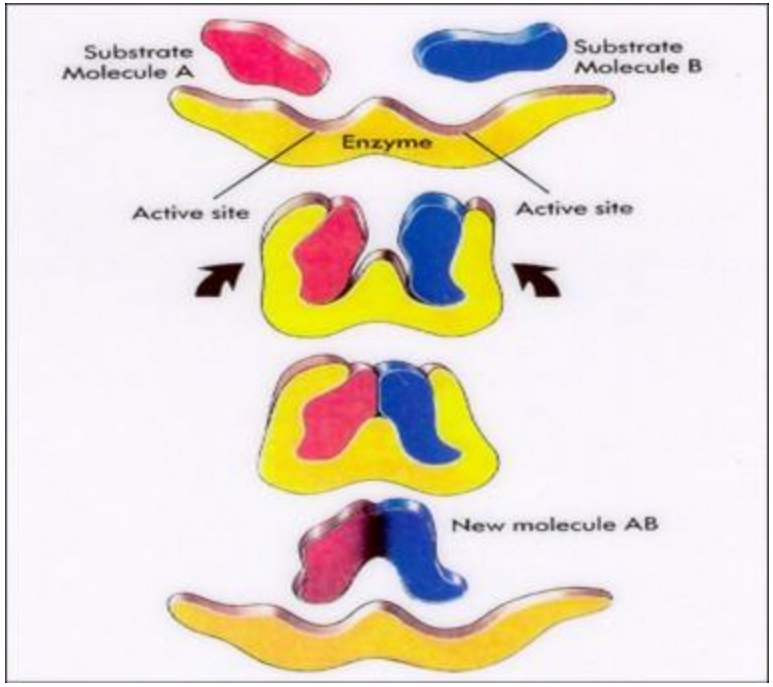
MEMBRANES and TRANSMEMBRANE CARRIERS





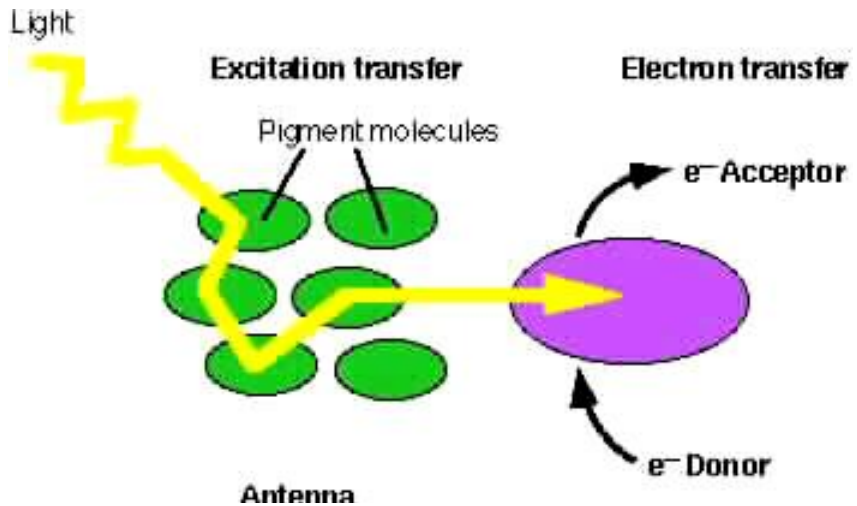
The original inspiration: Supramolecular systems in Nature

ENZYMES

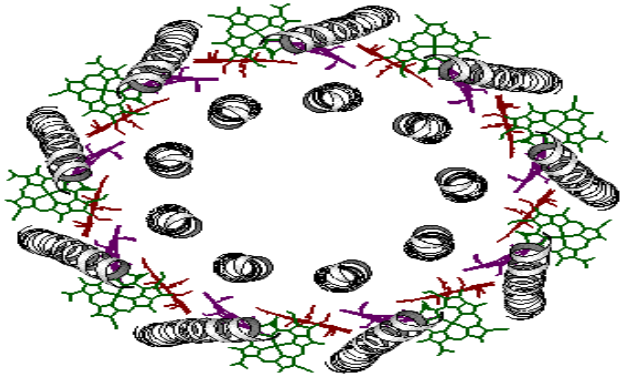


The original inspiration: Supramolecular systems in Nature

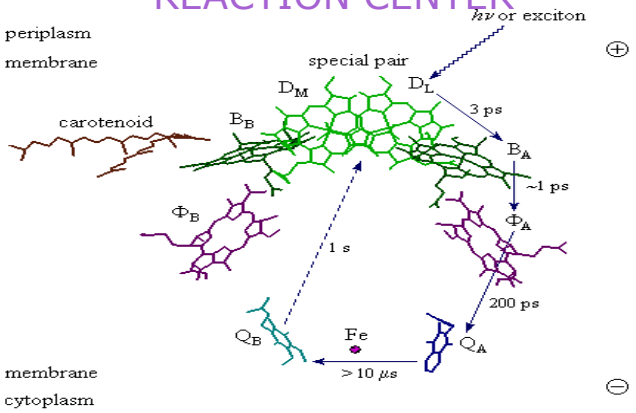
THE PHOTOSYNTHETIC APPARATUS



ANTENNA UNITS

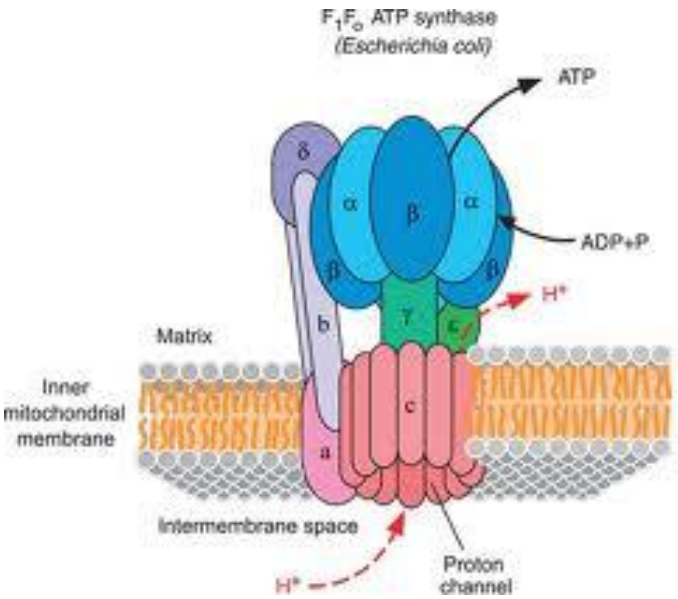


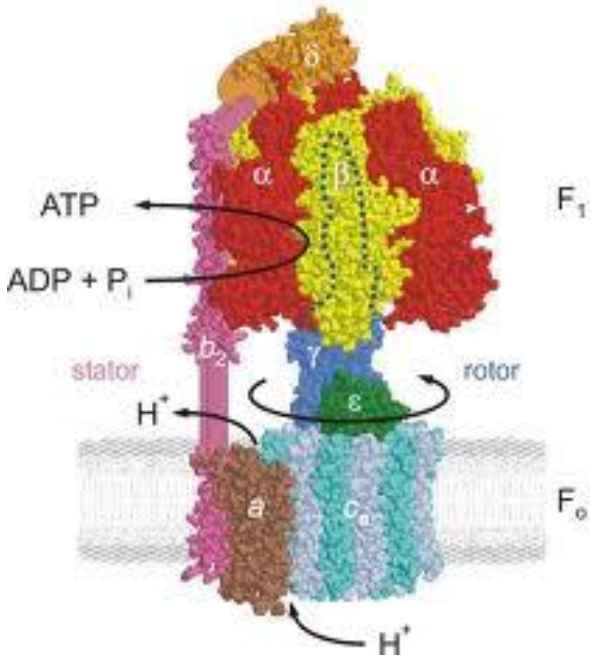
REACTION CENTER



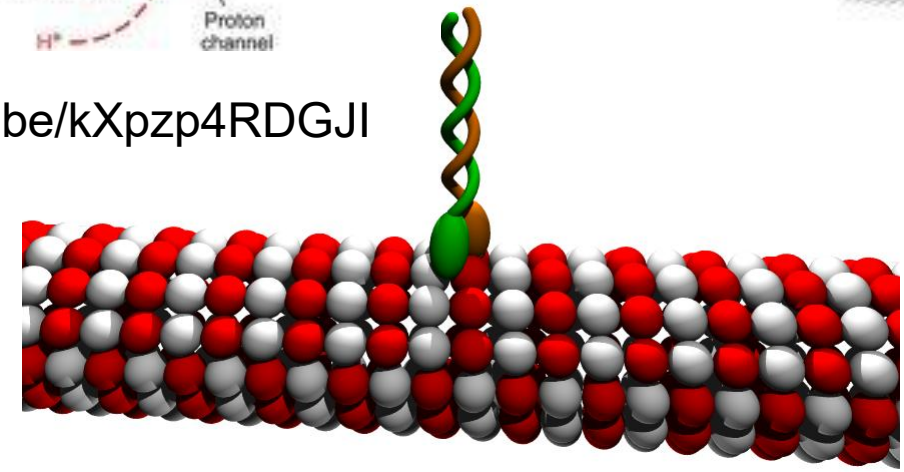
The original inspiration: Supramolecular systems in Nature

ATP Synthase and KINESIN





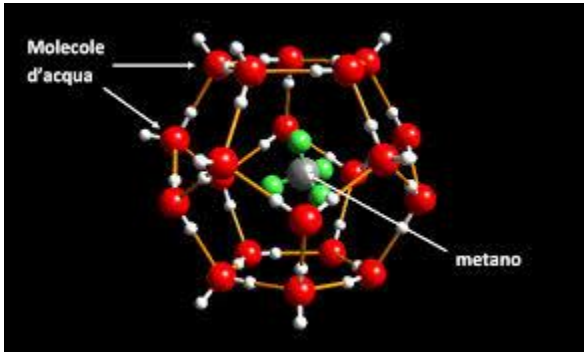
https://youtu.be/kXpzp4RDGJI



https://youtu.be/y-uuk4Pr2i8

The original inspiration: Supramolecular systems in Nature

METHANE CLATHRATE (Siberian craters)





Supramolecular Chemistry - definitions

- the chemistry beyond the molecules: molecules are already formed

- the chemistry of molecular assemblies and of the intermolecular bond: association of molecules

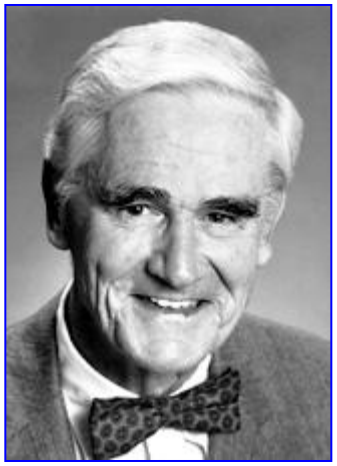
- the chemistry of the non-covalent bond: weak interactions

Bottom-up approach

Nano objects

Smart and functional materials

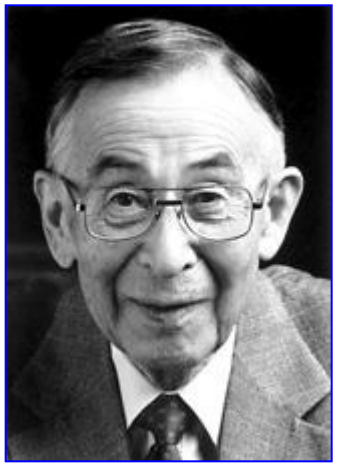
Nobel Prize in Chemistry, 1987



Donald J. Cram



Jean-Marie Lehn



Charles J. Pedersen

«for their development and use of molecules with structure-specific interactions of high selectivity»

http://nobelprize.org/nobel_prizes/chemistry/laureates/1987/

Nobel Prize in Chemistry, 2016



J-P. Sauvage



Sir J. F. Stoddart

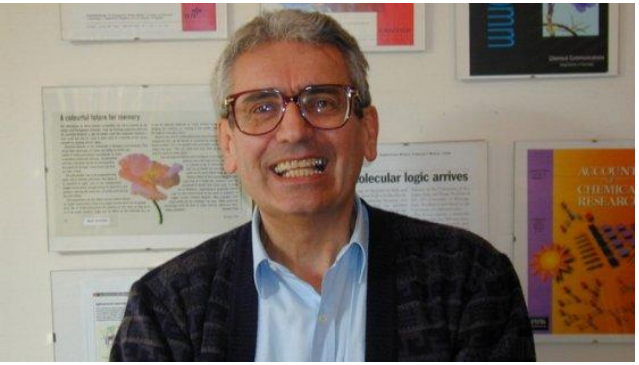


B. L. Feringa

"for the design and synthesis of molecular machines"

https://www.nobelprize.org/nobel_prizes/chemistry/laureates/2016/

The missed Nobel Prize



Prof. Vincenzo Balzani,
Emeritus Professor
University of Bologna

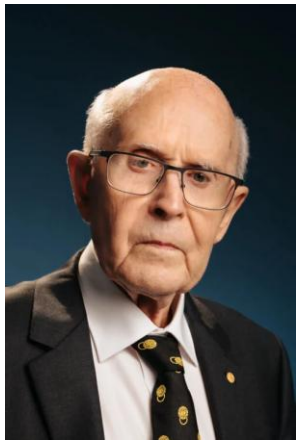
Scientific activity [edit]

He has carried out an intense scientific activity in the fields of photochemistry, photophysics, electron transfer reactions, supramolecular chemistry, nanotechnology, machines and devices at the molecular level, photochemical conversion of solar energy. With its 650 publications cited more than 64,000 times in the scientific literature (H index 119),[1] he is one of the best known chemists in the world. He is author or co-author of texts for researchers in English, some translated into Chinese and Japanese, which are currently adopted in universities in many countries. A few of the most significant texts are: Photochemistry of Coordination Compounds (1970), Supramolecular Photochemistry (1991), Molecular Devices and Machines - Concepts and Perspectives for the Nanoworld (2008), Energy for a Sustainable World (2011), Photochemistry and Photophysics: Concepts, Research, Applications (2014).

Nobel Prize in Chemistry, 2025



S. Kitagawa

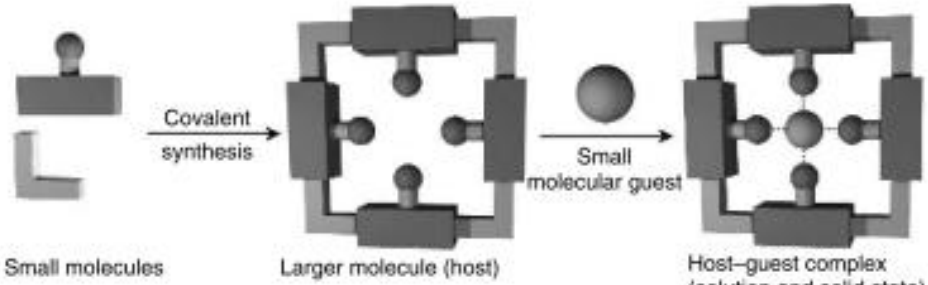


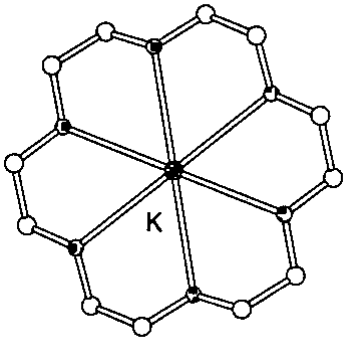
R. Robson

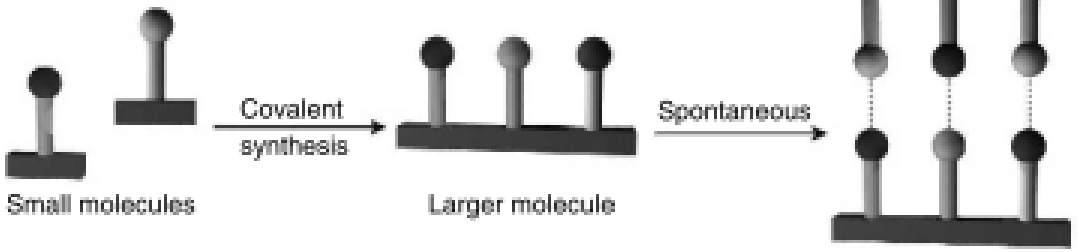


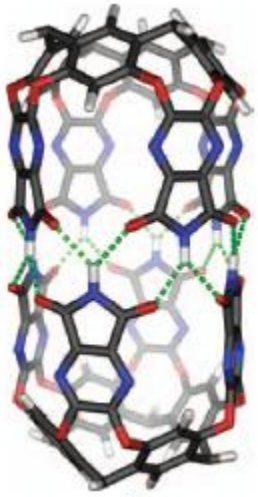
O. M. Yaghi

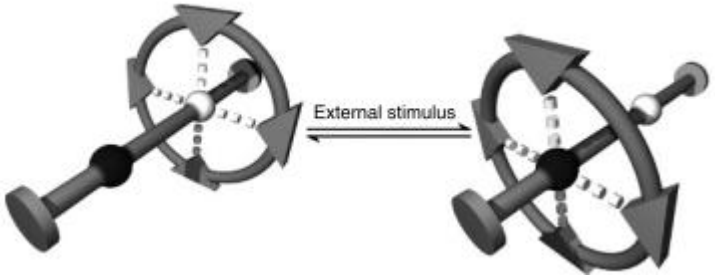
«for the development of a new type of molecular architecture: metal–organic frameworks. The constructions they created – contain large cavities in which molecules can flow in and out. Researchers have used them to harvest water from desert air, extract pollutants from water, capture carbon dioxide and store hydrogen.»



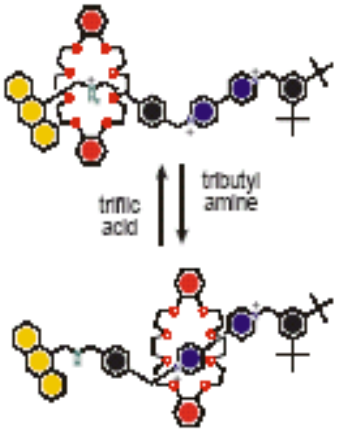




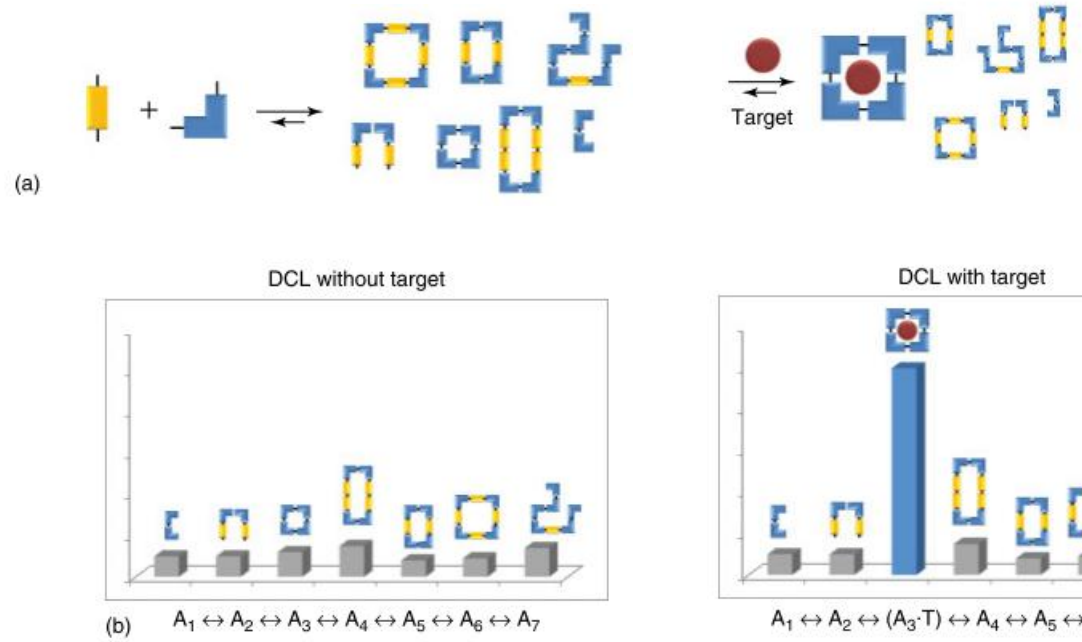




Rotaxanes and catenanes as molecular devices



DYNAMIC COMBINATORIAL CHEMISTRY



Preparation of a large number of different compounds (ideally) at the same time starting from a series of Building blocks – Dynamic Combinatorial Library

nature nanotechnology

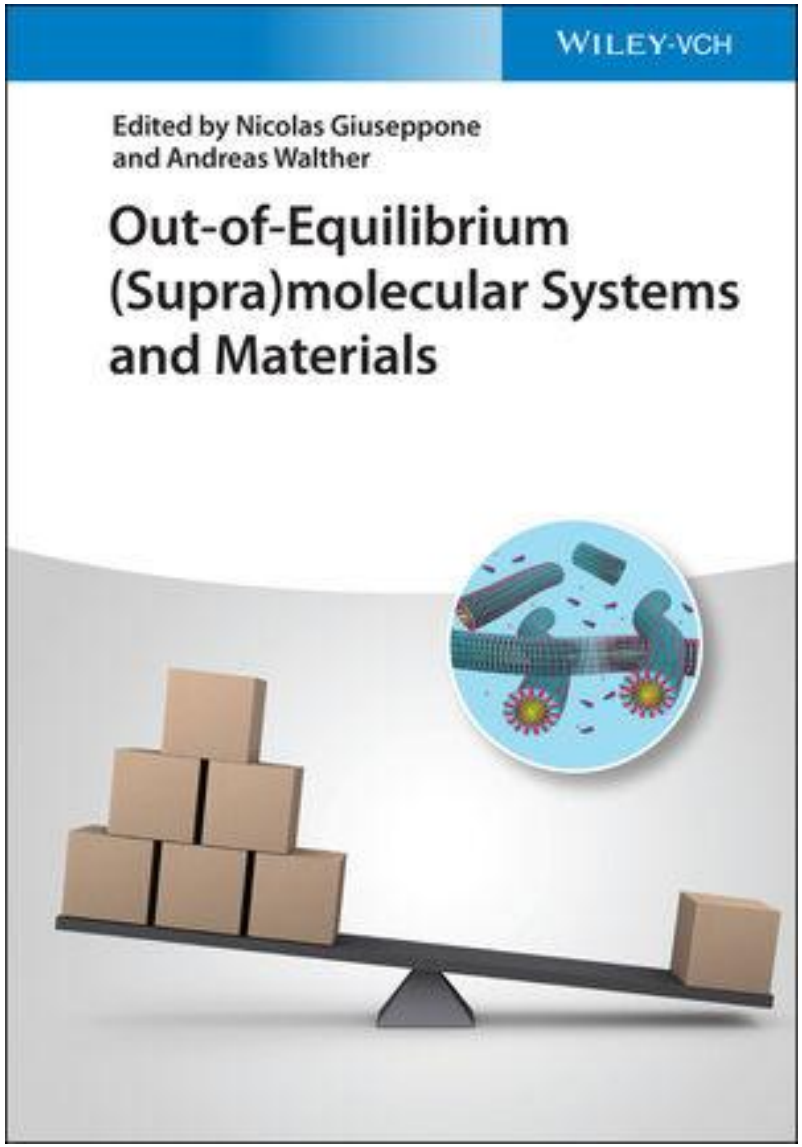
REVIEW ARTICLE

PUBLISHED ONLINE: 5 FEBRUARY 2015 | DOI: 10.1038/NNANO.2014.337

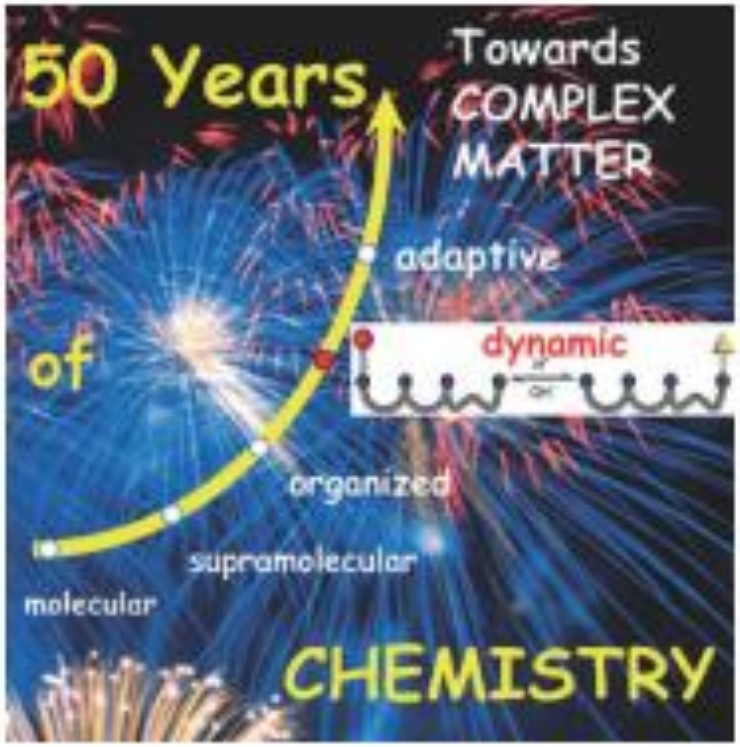
Supramolecular systems chemistry

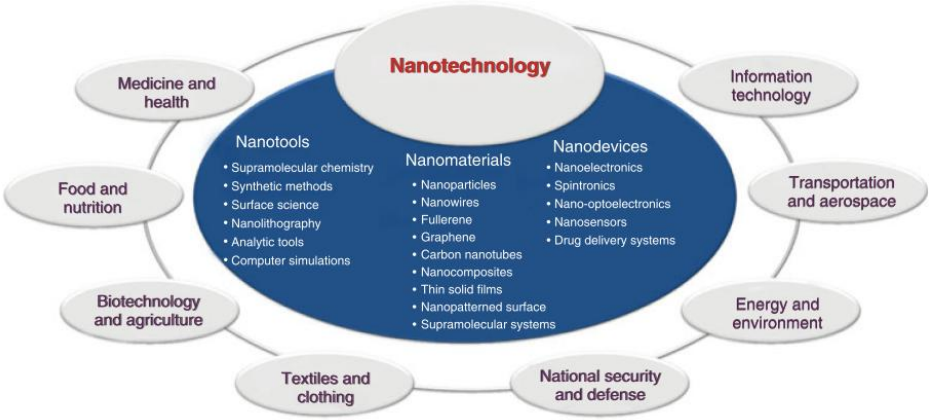
Elio Mattia and Sijbren Otto*

The field of supramolecular chemistry focuses on the non-covalent interactions between molecules that give rise to molecular recognition and self-assembly processes. Since most non-covalent interactions are relatively weak and form and break without significant activation barriers, many supramolecular systems are under thermodynamic control. Hence, traditionally, supramolecular chemistry has focused predominantly on systems at equilibrium. However, more recently, self-assembly processes that are governed by kinetics, where the outcome of the assembly process is dictated by the assembly pathway rather than the free energy of the final assembled state, are becoming topical. Within the kinetic regime it is possible to distinguish between systems that reside in a kinetic trap and systems that are far from equilibrium and require a continuous supply of energy to maintain a stationary state. In particular, the latter systems have vast functional potential, as they allow, in principle, for more elaborate structural and functional diversity of self-assembled systems — indeed, life is a prime example of a far-from-equilibrium system. In this Review, we compare the different thermodynamic regimes using some selected examples and discuss some of the challenges that need to be addressed when developing new functional supramolecular systems.


WILEY-VCH
Edited by Nicolas Giuseppone
and Andreas Walther
Out-of-Equilibrium
(Supra)molecular Systems
and Materials

From Supramolecular Chemistry to Nanotechnology





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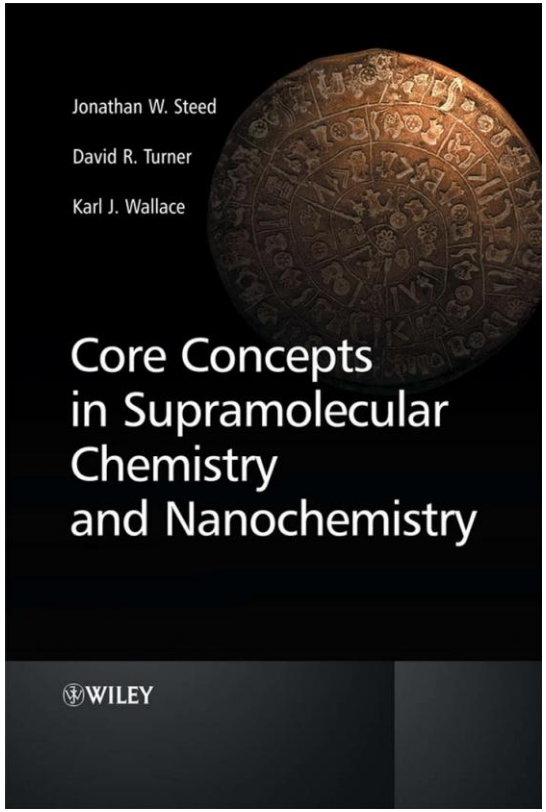
Jonathan W. Steed,
Durham University, UK

David R. Turner,
Monash University, Australia

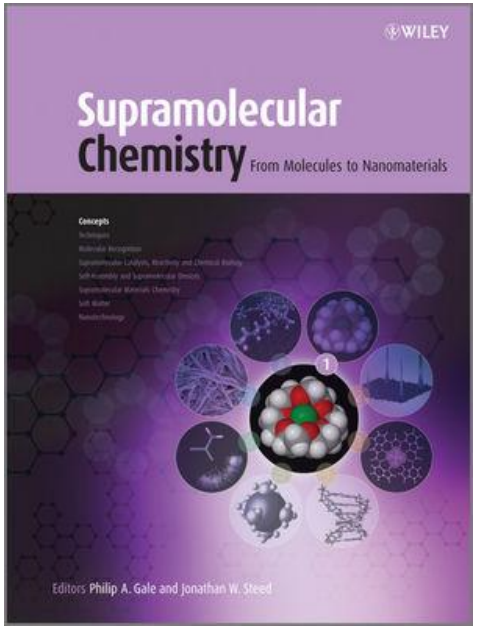
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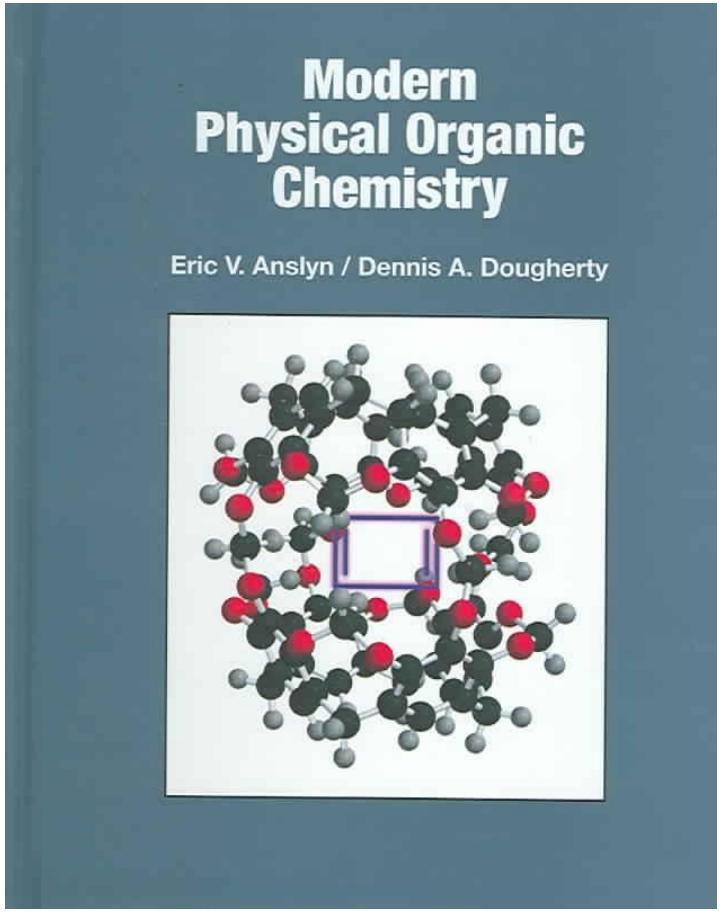


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Program

Non-covalent Interactions
Analytical Methods in Supramolecular Chemistry – a snapshot

Receptors for Cations
Receptors for Anions
Examples from the Literature – Paper Discussion

Cavitands
Covalent Molecular Containers
H-bonded Molecular Containers
Applications and examples from the Literature – Paper Discussion

Program

Helicates
*Cantenanes**
*Rotaxanes**
Knots
Paper Discussion

Molecular Machines
(chemical/electrochemical/photochemical stimuli)
Paper Discussion

**Prof. Benoit Colasson - Université Paris Cité*
4 hours teaching in the week 23-27 November



Prof. Benoit COLASSON

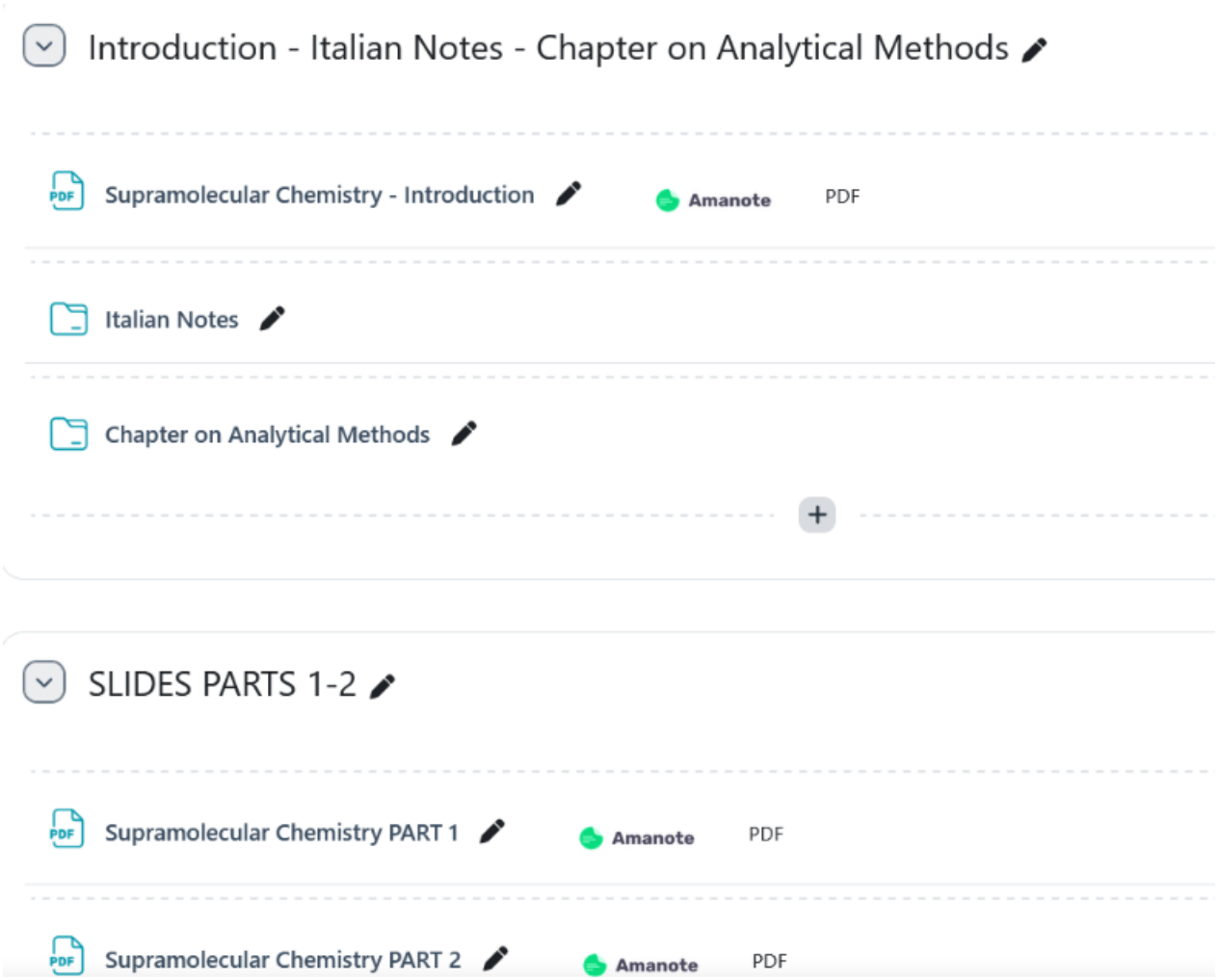
Professor, department of basic and biomedical Sciences, Faculty of Sciences

benoit.colasson@u-paris.fr

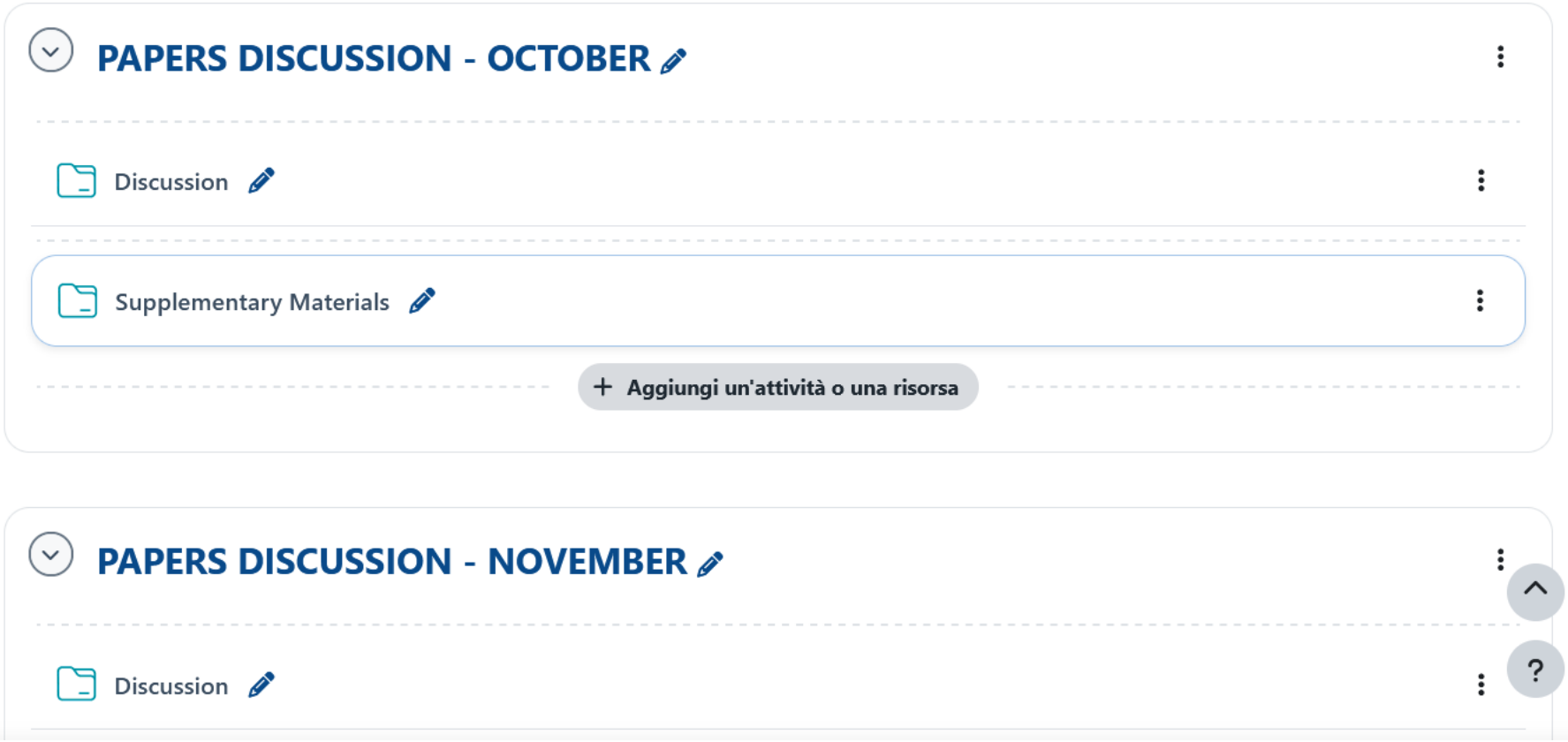
Benoit COLASSON, a member of the doctoral school's agitation committee, is a professor at *Université Paris Cité* and a researcher at the *Laboratoire de Chimie et Biochimie Pharmacologiques et Toxicologiques* (LCBPT – UMR 8601). After completing a doctorate in topological chemistry (Sauvage laboratory, *University of Strasbourg,* France), he conducted post-doctoral research (Fabbrizzi laboratory, *University of Pavia,* Italy, and Sharpless laboratory, *Scripps Research Institute,* San Diego, USA).

In 2006, he assumed the role of assistant professor in the LCBPT laboratory, concentrating on biomimetic coordination complexes based on calixarenes. **Presently, his research delves into using supramolecular chemistry to manipulate the properties of metal coordination complexes.** Alongside his research, he actively contributes to teaching chemistry at both undergraduate and postgraduate levels.

Material on *Moodle*



Material on *Moodle*



RECORDING ON MSTeams

Oral Exam (Discussion of a Literature Paper)