CHIMICA SUPRAMOLECOLARE

Leonard J. Prins, Fabrizio Mancin

Dipartimento di Scienze Chimiche, Edificio Chimica Organica

LP: I Piano, tel. 049 8275256, e-mail: leonard.prins@unipd.it

http://www.chimica.unipd.it/leonard.prins/

FM: II Piano, tel. 049 8275666, e-mail: fabrizio.mancin@unipd.it

http://www.chimica.unipd.it/fabrizio.mancin/

Chemistry

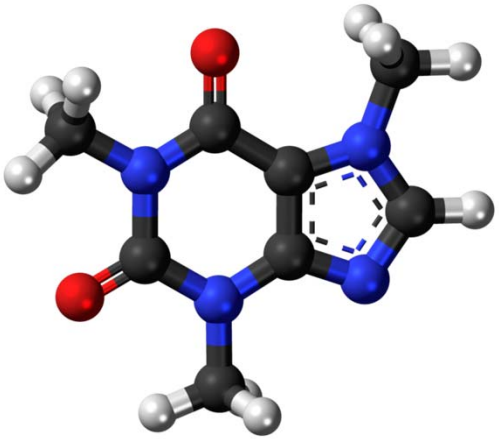
Chemistry is the study of the **nature**, **properties**, and **composition** of **matter**, and how these undergo **changes**…

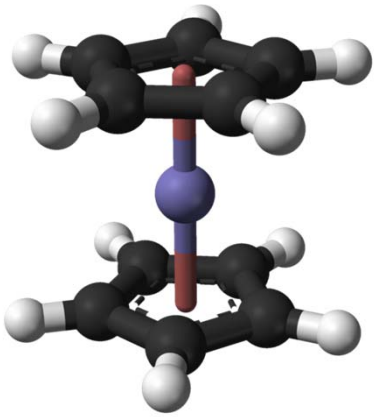
…One of the goals of chemistry is to be able to **describe the properties of matter in terms of its internal structure**… This word, structure, sometimes refers to the physical arrangement of particles, such as atoms or molecules in space. At other times it is used to indicate some other arrangement, such as the arrangement of energy levels of an electron in an atom. The structure of matter determines its properties.

A **chemical property describes a chemical change**: the interaction of one substance with another , or the change of one substance into another. Iron rusts in a moist environment, unrefrigerated milk turns sour, wood burns in air, photographs bleach when exposed to sunlight for a long time, dynamite explodes - each of these is a chemical property because each involves chemical change. During chemical changes, substances are actually changed into other substances. The simultaneous disappearance of some substances (called the reactants) and appearance of others (the products) is characteristic in chemical change (chemical reaction). Chemical changes are generally characterized by pronounced **internal structural rearrangements**…

John B. Russell, General Chemistry, McGraw-Hill International Book Company, 1980

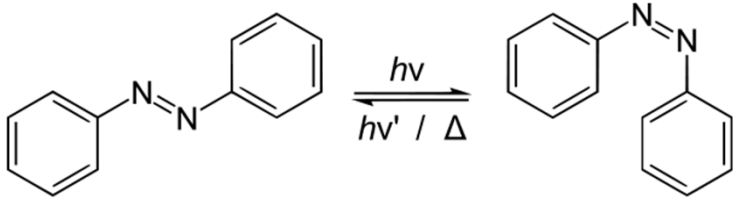
Chemistry



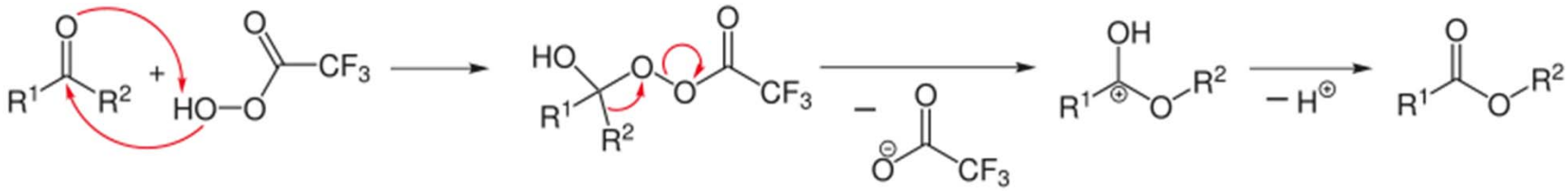


Molecules…

…reactions



trans-Azobenzol *cis*-Azobenzol



Supramolecular Chemistry

"Supramolecular chemistry is the chemistry of the **intermolecular bond**, covering the **structures** and **functions** of the entities formed by **association** of two or more chemical species."

J.-M. Lehn, Nobel prize lecture 1987

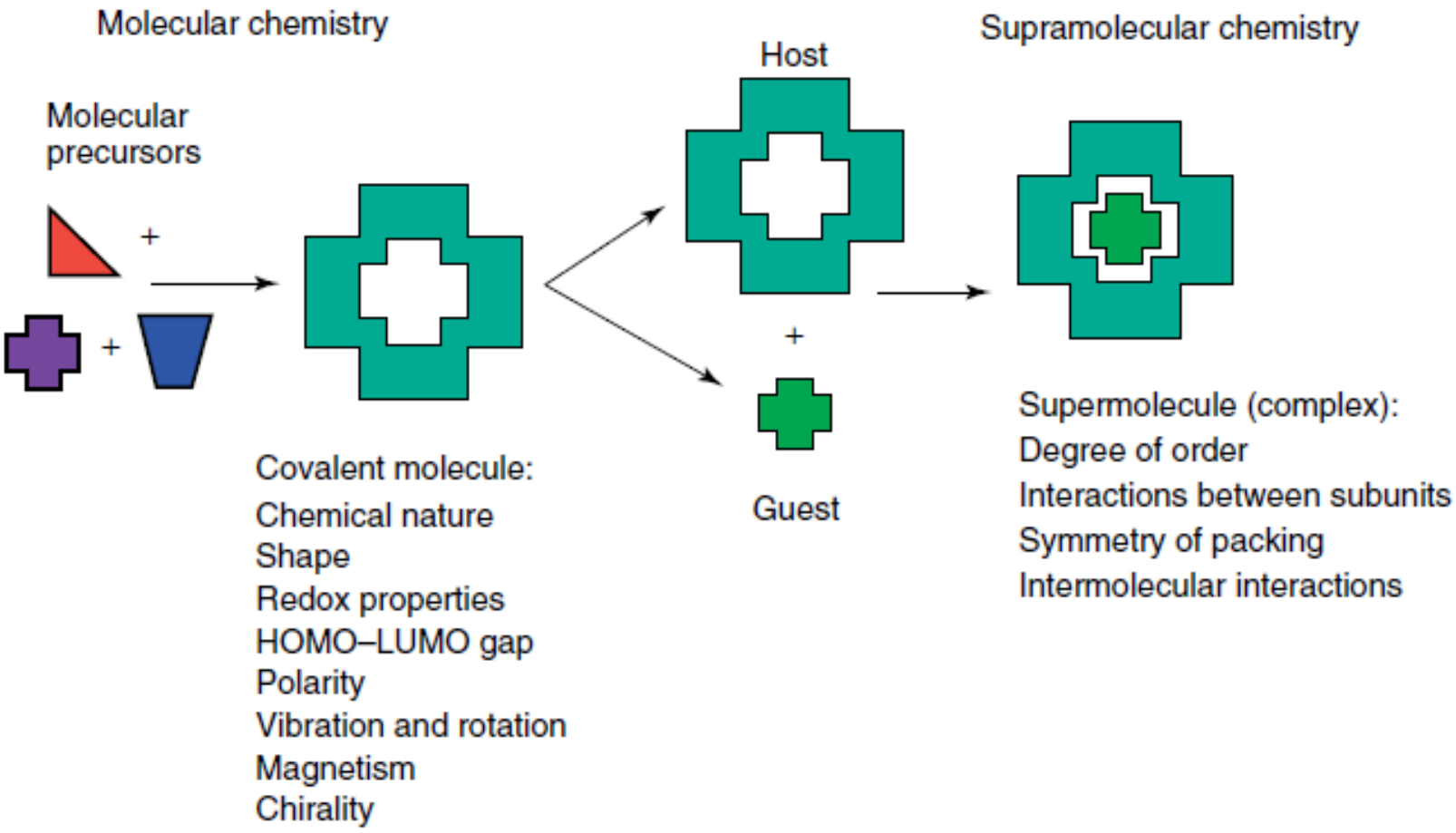
"Supramolecolar Chemistry may be defined as the chemistry "beyond the molecule", the chemistry of the **intermolecolar interactions**. In a supramolecule, **information** are stored in the form of specific structral aspects"

F. Voegtle, Bonn University

"the chemistry of the **non-covalent bond**"… "non-molecular chemistry"…

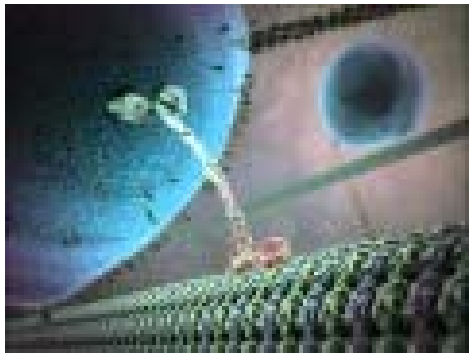
J. W. Steed, J. L. Atwood, Supramolecular Chemistry, Wiley

Supramolecular Chemistry



J.-M. Lehn, 1987

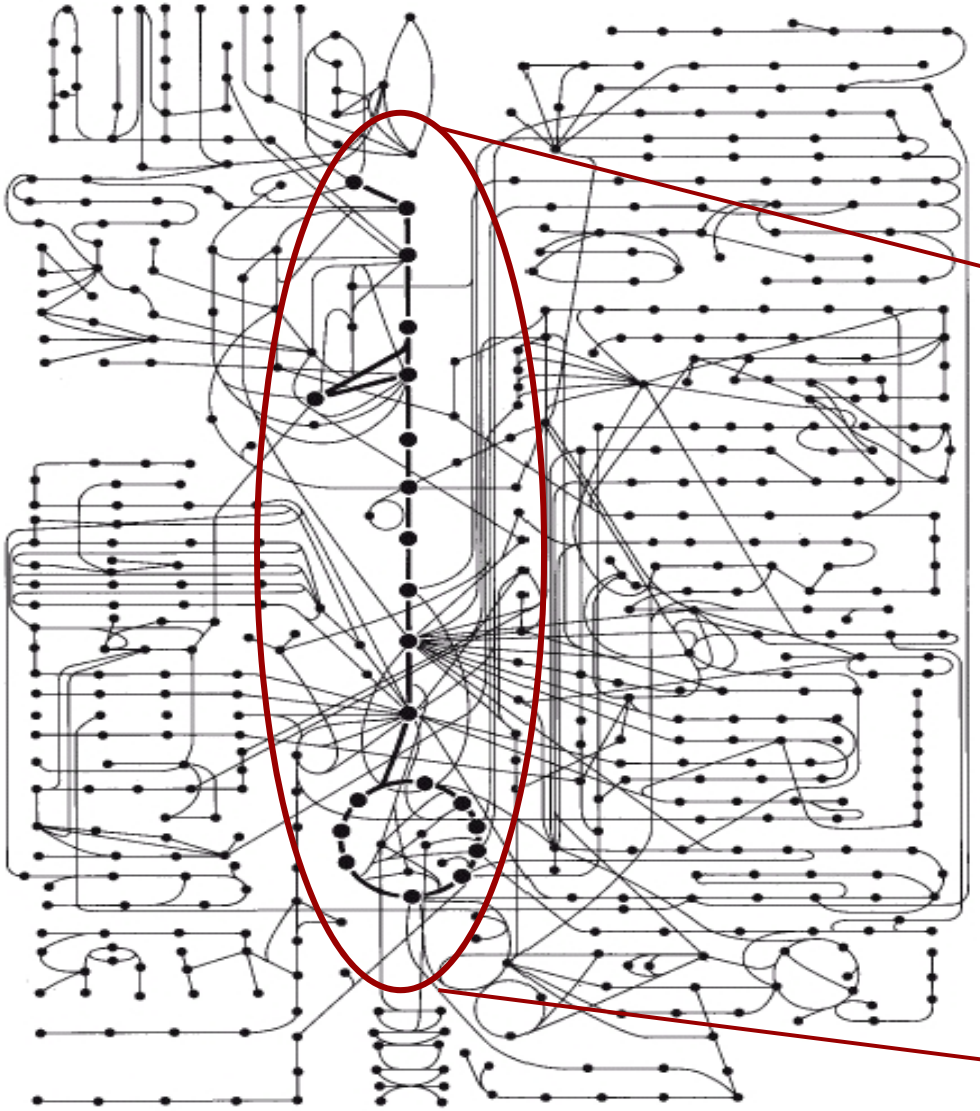
Supramolecular Chemistry in Nature



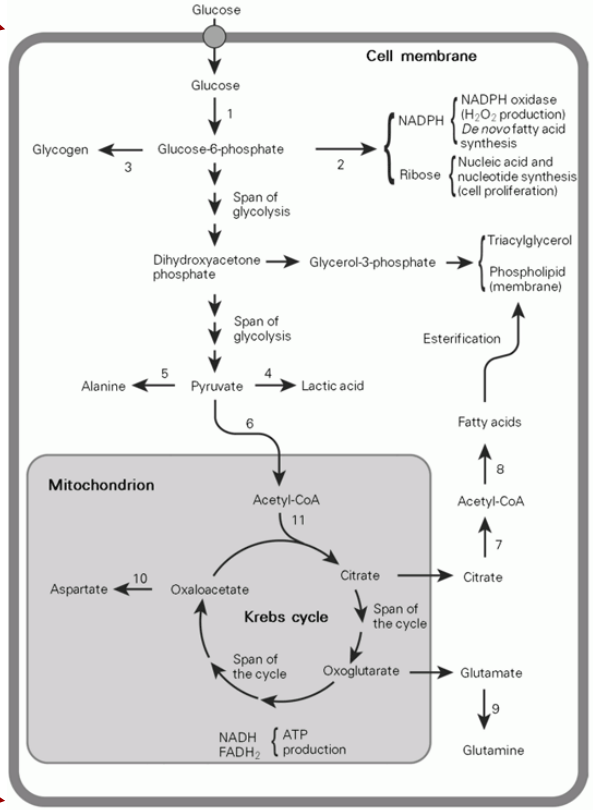
http://www.youtube.com/watch?v=wJyUtbn0O5Y

Why enzymes are so special?

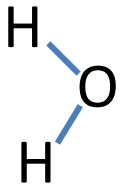
Complexity

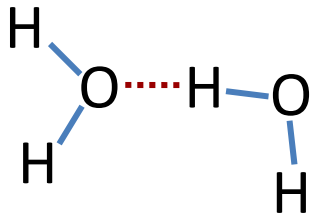


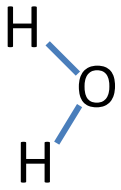
Map of the biotransformations occurring in a cell: each point represents a compound and each line an enzyme-catalyzed reaction



Supramolecular Chemistry

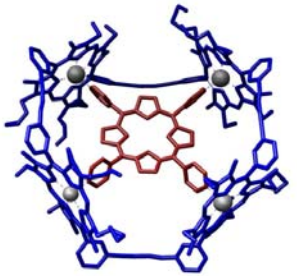


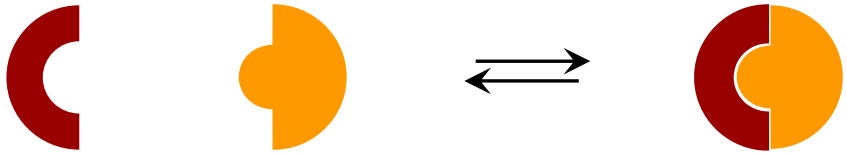




This is not a supramolecule!

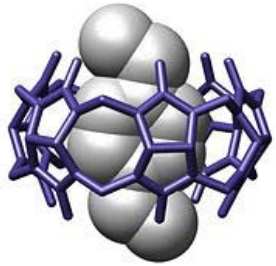
- ☺ Non-covalent interaction
- ☹ No selectivity
- ☹ No function

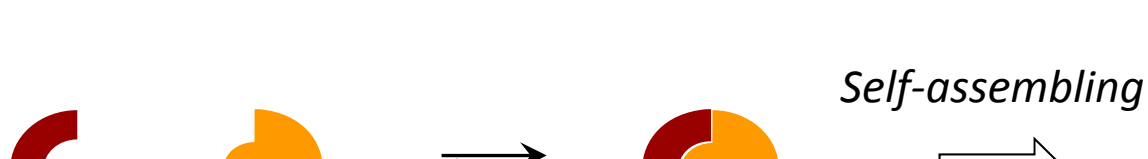




Host *Guest* *Supramolecule (host-guest complex)*

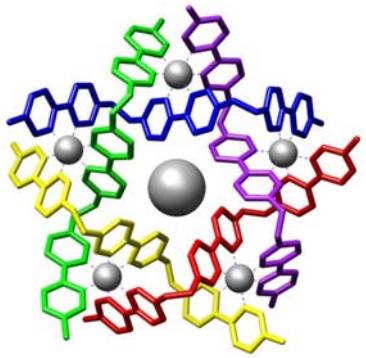
- Reversible
- Selective (recognition)



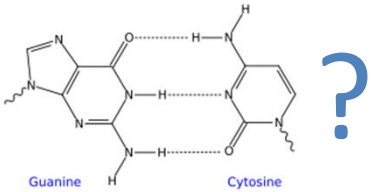


Host *Guest* *Supramolecule*

Self-assembling



Supramolecular Devices, Materials



?

Function

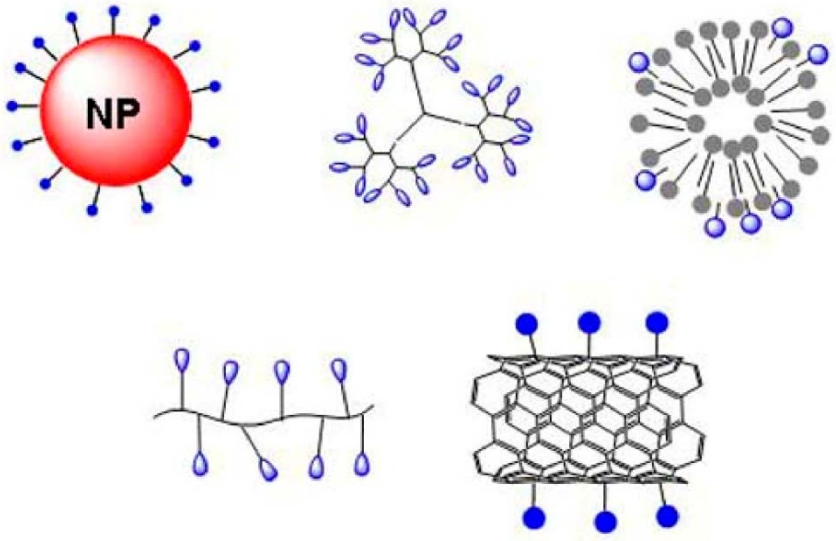
Catalysis
(transition state recognition)

Sensing
(recongnition and signalling)

Tranport
(Recognition and translocatoin)

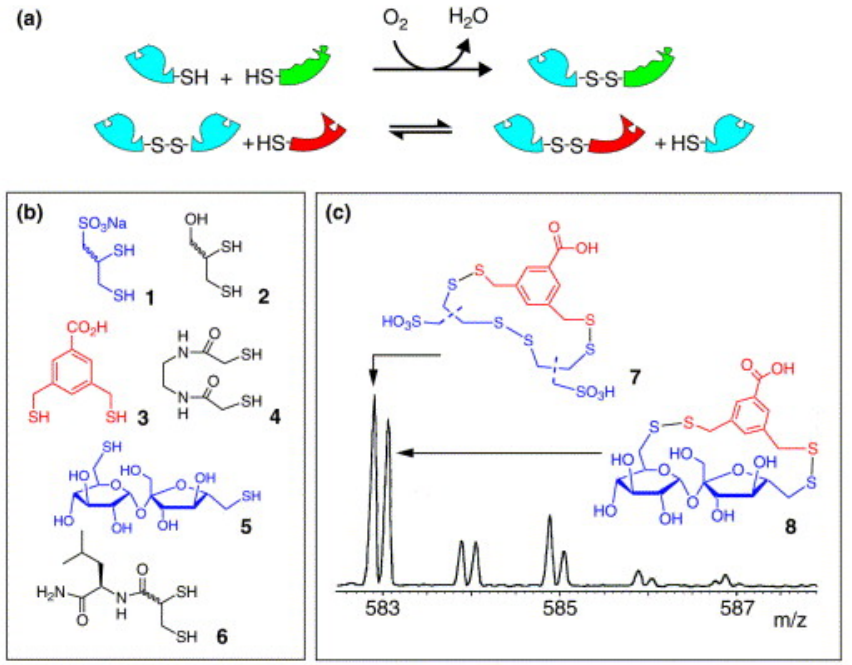
J.-M. Lehn, 1987

Supramolecular Systems



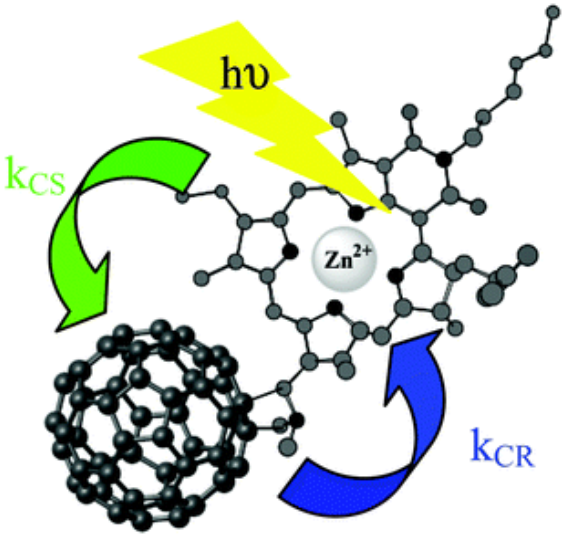
Multifunctional and multivalent systems

Self-adapting and evolving systems

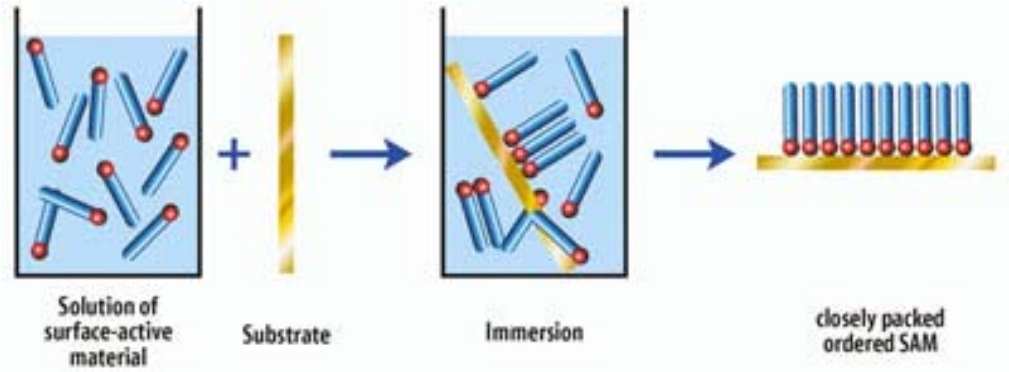


Current Opinion in Chemical Biology

Supramolecular Systems



Cooperative systems



Self-organized systems

New Definitions

- Group of molecular components that contribute properties that each component possess individually to the whole assembly (covalent or non-covalent)
- Self-assebled large molecules or molecular arrays
- Systems that encode “molecular information”

Program

Introduction

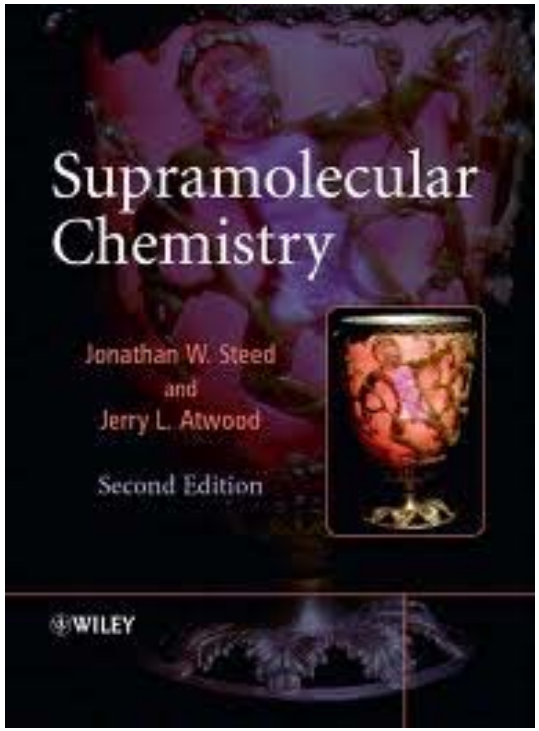
Fundamentals
- Noncovalent interactions, reversible covalent bonds, mechanical bonds
- Complex formation
- Determination of binding constants

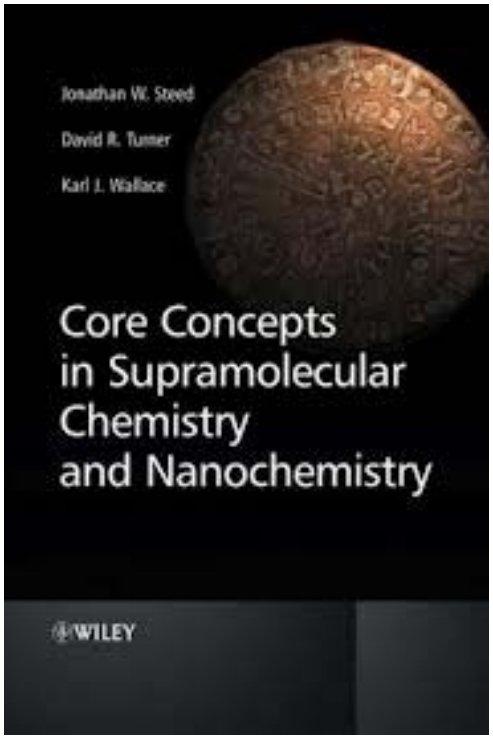
Systems
- Molecular receptors
- Surfactan aggreagates
- Nanoparticles
- Self-assembled monoalyers (SAMs)
- Supramolecular polymers
- Gels

Concepts
- Complementarity and preorganization
- Self-assembly
- Solvation effects
- Multivalency
- Cooperativity
- Supramolecular chirality

Applications
- Sensing
- Signal amplification
- Supramolecular catalysis
- Dynamic libraries
- Systems Chemistry
- Soft materials
- Molecular machines

Textbooks


Supramolecular Chemistry
Jonathan W. Steed
and
Jerry L. Atwood
Second Edition
WILEY


Jonathan W. Steed
David R. Turner
Karl J. Wallace
Core Concepts in Supramolecular Chemistry and Nanochemistry
WILEY