# [L1] From Interlocking and Knotted Rings to Molecular Machines

Jean-Pierre Sauvage

*Institut de Science et d'Ingénierie Supramoléculaires, Université de Strasbourg, F-67000 Strasbourg, France*

This lecture will provide an historical perspective of the field known as "chemical topology". The link between catenanes or rotaxanes and molecular machines will also be stressed.

The area named "Chemical Topology" is mostly concerned with molecules whose molecular graph is non planar, i.e. which can not be represented in a plane without crossing points. The most important family of such compounds is that of **catenanes**. The simplest catenane, a [2]catenane, consists of two interlocking rings. **Rotaxanes** consist of rings threaded by acyclic fragments (axes). These compounds have always been associated to catenanes although, strictly speaking, their molecular graphs are planar. Interlocking ring compounds have attracted much interest in the molecular sciences, first as pure synthetic challenges and, more recently, as components of functional materials. Knotted rings, such as the **trefoil knot** are particularly challenging systems. The synthesis of interlocking and knotted rings relies on templates (transition metals or organic assemblies). Highly functional and complex systems have been reported by several research teams, demonstrating the power of modern synthetic tools based on "template effects".

Separately, the research field of artificial **molecular machines** has experienced a spectacular development in the course of the last two decades. This new area is related to molecular devices at the nanometric level or mimics of biological motors. In biology, motor proteins are of the utmost importance in a large variety of processes essential to life (ATPase, a rotary motor, being particularly well understood and important). Artificial molecular machines have been designed and prepared using interlocking ring compounds or topologically planar systems. Particularly significant examples include "swinging catenanes", "molecular shuttles" or multi-rotaxanes reminiscent of "muscles" or able to act as "compressors". The molecules are set in motion using electrochemical, photonic or chemical signals. A few potential applications will also be discussed at the end of the lecture.