

Cancer therapy, fabrication and utilization of molecular devices as well as understanding biological catalysis are three topics that have been and will probably remain at the cutting edge of basic science. In the last 5-10 years these three topics have also become the focus of the new biotechnology and high-tech industry. This new reality is by no means a temporal trend and probably reflects three major developments: (1) the evolution, consolidation and even standardization of the molecular approach in advanced industries; (2) the awareness of leading scientists from the relevant academic disciplines of the technological opportunities and, (3) the desire of these scientists to see their innovations fabricated into the futuristic world. These developments have opened new avenues for educating Europe's scientists of tomorrow and to help in bridging the tremendous gap that still exists between the culture of basic science and that of the industrial partners.

I would like to share with you my own experience in trying to realize both goals, first in the laboratory and then at the institute in collaboration with other groups representing multiple scientific disciplines, and finally with industrial partners that undertook the translation of our scientific findings in the medical arena.

The key player in the described research is chlorophyll, the molecule responsible for the replenishment of atmospheric oxygen every ten years or so and for all useful organo-chemical energy on our planet. Chlorophylls are fairly large molecules, rich with delocalized electrons. In nature they harvest solar energy in different ecological niches and use it for charge separation across cellular membranes. The created potential provides the universal driving force for carbohydrate formation. We found that the collective properties of chlorophyll can be used to establish molecular reporters and radical generators within a selected microenvironment, other than the plant milieu. These observations were supported in our laboratory by using both computational and experimental approaches. Once established, we realized that the modified chlorophylls can serve as therapeutic agents e.g., for minimally invasive tumor eradication and for molecular tools such as a molecular potentiometer and molecular spring machines. The development of these two seemingly remote subjects in the same laboratory was found to be mutually beneficial. In the therapeutic arena, we synthesized novel chlorophyll derivatives that generate high bursts of oxygen radicals under near infra-red illumination in tumor domains after intravenous injection, causing selective occlusion of the entire tumor vasculature within minutes of illumination. This new treatment modality, termed vascular-targeted photodynamic therapy (VTP), is presently in phase II clinical trials against prostate cancer and will soon enter clinical trials against multiple vascular diseases. To enhance this rapid development of both drugs and modes of application, the industrial partner is actively involved at the very early stages after the innovative step has been launched. Furthermore, there is a constant flow of information between the industry, clinic, developmental laboratory, and students exposing them to the complementary role played by all sides in advancing basic/applied projects.

The chlorophyll experimental and computational chemistry invented en route to drug development, markedly profited and benefited from the molecular machines project and in fact their synergistic combination led to interesting new research programs and applications. Thus, recent projects in my group aim at drug design combine new QM-MM computational approach with considerations of protein flexibility and tissues response and encompass collaboration of students that have been trained in the aforementioned different disciplines.

In summary, by providing daily interactions between different research and developmental disciplines we train the students in walking between question and object oriented milestones and in recognizing technological opportunities, thus establishing the future bridge between academia and industry.