Synthetic and Natural Supramolecular Architectures: An Approach Towards Molecular Technology

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COURSE DURATION : 8 weeks

PRE-REQUISITES:

Basically no specific pre-requisite is necessary, but the student should have gone through basic chemistry courses at 12th & B.Sc. 1st, 2nd year level. They do not need to know chemical synthesis of organic molecules or inorganic compounds. All that they require is to be able to be familiar with writing and interpreting thv e chemical structures, the intermolecular forces of small molecules and biomolecules, and some general basic concepts and aspects of molecules (In any case these t/integrated in this course itself!)

INTENDED AUDIENCE : B.Tech (6th semester onwards), M.Tech./M.S./Ph.D. (1st semester onwards), Industry

COURSE OUTLINE :

The inspiration for framing this course on, "Synthetic and Natural Supramolecular Architectures: An Approach Towards Molecular Technology" has been derived from the chemistry Nobel prize2016 that was awarded to three scientists, Jean-Pierre Sauvage, Sir J. Fraser Stoddart and Bernard L. Feringa for their design and production of molecular machines. They have developed molecules with controllable movements, which can perform a task when energy (or any stimulus) is added. Therefore, this course is designed to equip the students of B.Tech. (in Chemical Engineering & Biotechnology) and the students of M.Sc. (in Chemistry & Biology/Biotechnology) with all the necessary ingredients to learn molecular assembly leading to the supramolecular architectures so that these are used in developing sensors, switches, devices and machines through a renowned phenomenon of chemical and biological sciences, known as, "Molecular Recognition", of course in a broad sense. This course will also take care of the parameters required to stimulate the process, such as, chemical, physical, biological, photon based, electrical, mechanical, magnetic, etc., and monitoring the output, in most cases it is the fluorescence emission and or colour change or any physical change. That means this course is developed to entice the students with the formation of supramolecular architectures of synthetic and natural (i.e., biological) ones in the direction to develop molecular technology. In this course we travel through the following chain of events, i.e., from a molecule supramolecular architecture molecular device molecular machine (i.e., to Molecular Technology). Overall, this course is intended to raise the confidence levels in the student to PRACTICALLY be able to engineer/design his/her own supramolecular architecture and should look (take it) forward to go to device making level, as a further activity (activity beyond this course). All this WITHOUT going into the details of the chemical synthesis of receptor molecules.

ABOUT INSTRUCTOR :

Prof. Chebrolu Pulla Rao is a J.C. Bose National Fellow and Professor at IIT Tirupati. Prior to this, he held an Institute Chair Professorship in the Department of Chemistry, IIT Bombay wherein he was a faculty during 1988-2019. He did his Masters from IIT Madras, Ph.D. from IISc., Bangalore, and two post doctoral stints one from Harvard University and the other from MIT, USA. His research interest spans across Biological Inorganic and Supramolecular chemistry using synthetic molecular systems as well as proteins with an extension of the studies to biological cells, and the efforts are way into nanobiomaterials. His research group extensively uses spectroscopy, microscopy and diffraction techniques besides practicing biochemical methodologies including antiproliferative activity. Till now 37 PhD and 59 MSc students completed their degrees and published about 240 papers in journals of international repute and completed a number of research projects sponsored by Department of Science and Technology (SERB, Nano Mission), Council for Scientific and Industrial Research and Department of Atomic Energy-Board for Research in Nuclear Sciences. To its credit, the group has 3 US patents and 7 Indian patents awarded. He is a fellow of Indian National Science Academy (FNA), Indian Academy of Sciences Bangalore (FASc), National Academy of Sciences Allahabad (FNASc) and Andhra Pradesh Academy of Sciences (FAPAS) and is a CRSI silver medalist. He has served onthe editorial board of IJC A for over ten years and the Journal of Chemical Sciences for three years.

COURSE PLAN :

Week 1 : Introduction to Supramolecular Science & Technology; Molecular vs. Supramolecular; A quick travel through supramolecular architectures of synthetic & natural systems

Week 2 : Non-Covalent & Weak Interactions; Donor – Acceptor Concepts; Coordination Characteristics: Chelate & Macrocyclic Effects.

Week 3 : Synthetic & biological Receptors; Single and multiple Ion & Molecular Recognition in chemistry & biology and their transport in biology; Role of fluorescence spectroscopy in supramolecular science.

Week 4 : Supramolecular systems such as calixarenes, pillararenes, cucurbiturils as receptors in recognition

Week 5 : Property driven functions in supramolecular architectures

Week 6 : Metal coordinated special architectures: Molecular knots, catenanes, cages, capsules, tubes, necklaces and other types.

Week 7 : Engineering Supramolecular Architectures: Sensors, switches, devices & machines

Week 8 : Connectivity & Comparison: simple molecule supramolecular architecture molecular device molecular machine (i.e., a quick walk through Molecular Technology) Last but not the least: Raise confidence levels in the student to engineer/design his/her own supramolecular architecture and look forward to go to device making level, as a further activity (activity beyond this course).