Interface in Chemical and Biological Sciences: Biochemical Exploration and Conceptualization (BEACON)

21 Feb 2015

WORKSHOP REPORT

Brindavan Campus

Department of **Chemistry & Biosciences**

Objectives of the Workshop

- To understand and appreciate the inter-relationship and inter-dependence of Biosciences and Chemistry
- To provide awareness of the type of exciting research that is going on the world over in Industry and Academia.
- To provide an appreciation of how class room learning is actually very important in careers both in industries and science.

SESSION I

Speaker 1: Prof. Laxminarayana
Topic: "Electrochemistry of Nanochemistry"

The speaker discussed two important applications of electrochemistry in Nanochemistry – Energy generation and Biosensors. He emphasized the need for cleaner energy to reduce dependence on fossil fuels. Fuel cells have become a subject of intense study in this respect. The hydrogen-oxygen fuel cell was considered as a case in point. Several challenges and solutions with respect to their use in the automobile industry were discussed. The second application: use of nano-chemistry in biosensors, can go a long way in helping humanity; for example, in replacing handheld glucometers and insulin pumps used by diabetic patients. Since electrochemistry is used in these and many other applications of nanoparticles, it may be described as the 'Workhorse of Nanotechnology'.

Speaker 2: Dr. Ramesh Sistla
Topic: "Structure based design of inhibitors" was a classic example of chemistry-biology interface

He began by reiterating that "All biology is chemistry, all chemistry is physics, all physics is mathematics." Taking drug design as an example he proved that the boundaries across disciplines of science are dissolving. Classical methods of drug development were primitive and often helped by serendipity. As diseases get more and more complex, the responsibility of developing drugs to counter these diseases have led to the modern methods of drug design. Modern drug design involves high throughput screening, ligand based design, combinatorial chemistry, and structure based design. All these methods are aimed at finding the LEAD compound followed by LEAD modification – finding the variants of LEAD compound, to improve potency, affinity and interaction of drugs. The speaker explained how these methods are helping in tackling cancer. He ended his presentation with a case study of how Imantinib is used to counter chronic myeloid leukaemia.

SESSION II

Speaker 3: Prof. V Nagaraja
Topic: Metagenomics: A revolution in Biology

Professor Nagaraja, brought out in great detail and depth the new path breaking field in biotechnology namely, metagenomics. The broad field may also be referred to as environmental genomics, ecogenomics or community genomics. Metagenomics is the study of genetic material recovered directly from environmental samples. He brought out the shocking fact that in spite of the tremendous scientific advancements, we are able to culture less than 1% of all the bacterial forms in the world. There is a huge world of unculturable bacteria and this area is a gold mine for research. Microbial genome information was available till lately only for cultureable bacteria. Early environmental gene sequencing of the 16S rRNA revealed that the vast majority of microbial genetic diversity found in this approach was missed out in the traditional approaches.

The speaker brought out the two approaches of study:(i)the functional screening approach and (ii) the sequence driven approach. The latter is more popular and is based on the 16s rRNA sequences of various organisms. Since the 16S rRNA sequence is highly conserved, occurrence of a new sequence in a microbe indicates that it is a new species. Present advancements in sequencing likeshotgun sequencing, next-generation sequencing, provide us with the genetic information of hidden diversity of microscopic life. The information flow over the last few years, has caused an explosion in the tree of life, with millions of new species brought on board.

The speaker astounded the audience by revealing that there are more number of bacteria in the human body than thenumber of cells in the human body. The importance of entire microbial population in an organism, the microbiome, is becoming more evident

with the metagenomics approach. The speaker made it evident, as to how the microbiome is distinct between two individuals and that, even identical twins are not an exception to this. The individual's genes, his /her diet and the external environment etc., influence the microbiome. He also alluded to the point that many of the diseases hitherto not linked to known microbes are probably because ofsome species of the microbiome. This also opens up a whole area for drug design and discovery.

Speaker 4: Prof. DN Rao
Topic: Genomics of Restriction –modification systems

The speaker highlighted how the restriction-modification systems (R-M systems), were discovered based on the fact that certain bacterial strains restrict the growth of bacteriophages grown in other strains. Primarily, R-M systems are used by bacteria to protect themselves against infection by the bacteriophages. They use the restriction enzymes, which cleave the DNA of the invade bacteriophage at specific points. Approximately one-quarter of known bacteria possess R-M systems and more than one half of them have more than one type of R-M system. The speaker then explained, how the bacterium itself has many of the sequences that could be cleaved by its own R-M system, but it protects its own DNA by adding methyl groups and thereby modifying only a few specific bases on each strand. The methylase part of the R-M system participates in the protection by methylating the bases. Professor D.N. Rao, further went on to discuss that there are five kinds of restriction modification systems: type I, type II, type IIS, type III and type IV, each having a restriction enzyme activity and a methylase activity. He brought out how the entire system is in a state of constant dynamic evolution with more R-M systems being found out each week, using various bioinformatics approaches, following the explosion in the field of metagenomics.

The speaker concluded his talk by presenting how the bacteriophages have evolved to overcome the R-M systems in bacteria. T7 phage produces a protein called, OCR (Overcome Classical Restrcition), which structurally mimics the phosphate backbone of B-form DNA.

The speaker then discussed about the presence of more than 20-25 R-M potential regions in the genome of several species of bacteria, whose functions are yet to be fully elucidated. He invited all the young minds to take up exploring such systems and also stated that E.coli is still as fresh as it was in the 1970's for studying life at molecular level. He concluded his talk by stating that discovering new R-M systems can boost drug discovery studies, and help us design novel antibiotics and contribute a great deal to human health care.

SESSION III

Speaker 5: Prof. R Manjunath
Topic: Self, Non-self and Danger: Basic concepts in the immunological study, diagnosis and treatment of infections"

Professor Manjunath, brought out the discoveries in the field of immunology and elaborated them from a historical perspective with lucid narratives.His talk kindled enthusiasm in students to learn more about the functioning of immune system. He presented the concepts of innate immunity and acquired immunity and further elaborated on how immune system is trained to differentiate self from non-self.

He brought out the following points with illustrative slides. The Innate immune system is the first line of defense against infection and it is rapid; causes acute inflammatory response but with low specificity and lacks memory; thatAdaptive immunity although slow is highly specific and elicits memory response.He explained that the two arms of the latter are i) cell-mediated immunity: mediated by the T-cells and ii) Humoral immunity: mediated by the B-cells via antibodies. He explained the crucial role of CD4+ T cells in aiding B-cells in mounting and amplifying the humoral response.

He explained a few of the immunological techniques in simple words, such that students from both the chemistry and biology streams could easily understand like:antigen-antibody interactions and how this has formed the basis for several immunological techniques; likeImmunoelectrophoresis, Enzyme-linked immunosorbent assay (ELISA), Radio Immuno Assay (RIA), Flow cytometry etc.

Speaker: J Sai Kiran
Topic: Clinical Chemistry

The final talk was given by J. Sai Kiran. His talk focused on the various diagnostic tools that are being used in the Sri Sathya Sai Institute of Higher Medical Sciences, SSSIHMS, Whitefield. He mainly focused on the importance of concepts of biology, chemistry and physics involved in each of the diagnostic techniques. He started his talk stating that a clinical lab uses a wide range of techniques ranging from simple to complex ones and brought out how factors like time, cost and the inferences that need to

be drawn out, influence the analytical methods of choice. He brought out that diagnosis, as a procedure, can be regarded as an attempt at classification of an individual's condition into distinct categories that allow medical decisions to be made about treatment and prognosis. He also brought out the subtle and explicit differences between a clinical lab and research lab.

He elaborated on the use of various instruments, their working principle, the procedures involved, the sample volume required to perform the test, and most importantly, inferences drawn from them. He discussed how colorimetry, absorption spectroscopy, ELISA, Radio immuno assays (RIA), Western blot, flow cytometry, cell counter, PCR etc are used in medical diagnosis. Small video clips were used to enhance the student's understanding. The speaker then, elaborated on how automation plays a very crucial role in quick, unbiased and correct diagnosis. He added that automated BacT/Alert is used for the colorimetric detection of CO2 produced by growing microorganisms. The manual process takes several hours to few days, while the automated detection system scans CO2 levels every 10 minutes and completes the process in a few hours, facilitating quick decision making regarding treatment.