Review Article

Status of Chemical Biology in India

SANDEEP VERMA

Department of Chemistry and Center for Nanoscience, IIT Kanpur, Kanpur 208 016, India

(Received on 03 March 2019; Revised on 25 May 2019; Accepted on 05 June 2019)

This overview endeavors to present a status report of chemical biology research in India starting a brief history of its roots, connection to other disciplines, current expertise base and involvement of societies at national and international level to bring about a movement in the forward direction. Given the reach and rigor of chemical biology and its envisaged applications in supporting investigations of fundamental nature and translational value, it is imperative that academic community be guided through orchestrated nationwide programs focused in leveraging existing expertise and training of future leaders, in order to create excellent human resources for future growth of this domain in academia and industry.

Keywords: Chemical Biology; Biochemical; Research Protocols

Introduction

It is generally agreed that Chemical Biology as a discipline germinated in the last 30 years since chemists decided to cross an indivisible line in order to probe biological systems with rationally designed small molecules not only to understand their biological effects, but also to chemically interrogate complex biochemical pathways to gain more clarity about underlying molecular interactions to generate downstream knowledge for identification of novel biological targets for drugs, follow up of biomarkers and diagnostics. Iterative refinement of chemical matter and small molecules often allows very precise interactions to visualize and engineer complex biological systems, to finally reveal most optimum chemical outcomes for useful biological insights.

Arguably, one of the early usages of the term 'Chemical Biology' could possibly be traced to 1930, when J B Leathes published a paper, with an astonishing narrative for that era, titled '*The Birth of Chemical Biology*' (Leathes, 1930). Half a century later, Arthur Kornberg (Nobel Laureate in Medicine, 1959) aptly articulated prevailing views at that time "...chemistry and biology are two distinctive cultures and the rift between them is serious, generally unappreciated, and counterproductive"

(Kornberg 1987). But, fortunately these two disciplines quickly forged a way ahead and many outstanding research problems, including the advent of *omics* research era, challenge of unmet medical needs, and theranostics, to name a few, were looked at more effectively due to intimate union of these disciplines. These challenges and successes further eroded distinctive dividing lines bringing chemistry and biology much closer and intertwined them to create newer areas of investigation, research protocols and tools. There has been a noticeable excitement in chemical biology community over the last two decades and this transdisciplinary area holds immense promise for future, which reflected in renaming of chemistry departments around the world, funding opportunities, launch of new journals and conferences <https://www.omicsonline.org/chemical-biology-journals-conferences-list>.

The strong connection of chemistry and biology interface in chemical biology primarily deals with close scrutiny of endogenous or designed exogenous small molecules that could influence biological processes with a predictable outcome. Blurring boundaries of subsequent investigations and mechanistic follow up requires masterful contributions from a variety of disciplines such as organic and bioorganic chemistry, biochemistry, cell and molecular biology, and

*Author for Correspondence: E-mail: sverma@iitk.ac.in

pharmacology, to name a few, with strong support from imaging and microscopy.

Other than disparate research efforts, the major fillip of consolidation of chemical biology research in India came about when “Indian Institute of Experimental Medicine (IEM)” at Kolkata (established in 1935) was renamed as “Indian Institute of Chemical Biology (IICB)”, in 1982. Notably, chemical biology research is actively pursued in many academic and research institutions around India, with an emphasis on expertise in nucleic acid structure and dynamics, synthetic biology, biomolecule-small molecule interactions, mechanism-based therapeutics, protein structure and peptide biology, antimicrobials and drug resistance, among many others Selvi, Roy and Kundu (2011). It is expected that newer developments in the areas of molecular optogenetics, chemical biology of redox metabolic systems, posttranslational modifications and cellular reprogramming, will also find interest in Indian chemical biology community.

A lacuna in Indian landscape of chemical biology emanates from lack of trained students who have had grinding in the discipline through carefully designed courses at both undergraduate and postgraduate levels. To nurture such a thought process, it is becoming evident worldwide that chemistry curriculum should be modified to preserve the rigor of traditional chemistry pedagogy, yet offer an in-depth exposure to biological principles including chemistry and biology of cellular and subcellular systems (Begley, 2005). A thorough grounding of other relevant areas such as bioorganic, bioinorganic, biophysical, bioanalytical, and biochemistry, is also essential. Given the subtle shift of thematic focus of funding opportunities, a number of younger chemistry faculty members in IITs, IISERs, JNCASR, universities and research institutions, also provide impetus for developing right curricula and deeper learning from biology colleagues. The latter could be achieved by double major/minor academic degrees, team-taught modular courses in biology, and laboratory rotations for chemistry students, while short focused courses in organic, physical and analytical chemistry could be designed for the biology students.

At the national level, “Chemical Biology Society (CBS)” of India has been registered as a Scientific

Society, with due recognition by the International Chemical Biology Society and also a few other Societies, to encourage and foster interactions, creativity and synergy, at the interface of chemistry and biology <https://www.cbs-india.org/index.html>. As an international outreach, India has also become a valuable partner and member state in Asian Chemical Biology Initiative (Japan), which has ~100 researcher professors as participants <https://www.asianchembio.com>. It has a mission to accelerate chemical biology research in Asia by networking international collaboration partners from Japan, Korea, China (the mainland and Hong Kong), Singapore, UAE, India, and New Zealand, and to promote the discipline in emerging Asian countries such as Vietnam, The Philippines, Thailand, Malaysia, Indonesia, Mongolia, and Myanmar.

With intensive research activities, enhanced funding, and a slew of young students motivated to pursue science as chosen career, the time appears to be ripe for the Indian academia to retrofit chemistry programs to bring in fresh perspectives to groom a new generation of students equipped with appropriate knowledge for cutting edge research at chemistry-biology interface. Incidentally, this outstanding synergy is quite evident from the Nobel Prizes in Chemistry in the last decade, where problems inextricably interwoven with biology have vied for the highest recognition. Indian academic landscape should embrace the changing face of chemistry education worldwide and offer innovation to create a robust baseline for frontier research.

References

- Begley T P (2005) Chemical biology: An educational challenge for chemistry departments *Nature Chem Biol* **1** 236-238
<https://www.omicsonline.org/chemical-biology-journals-conferences-list.php>
<http://www.cbs-india.org/index.html>
<https://www.asianchembio.com>.
- Kornberg A (1987) The two cultures: chemistry and biology *Biochemistry* **26** 6888-6891
- Leathes J B (1930) The birth of chemical biology *Lancet* **216** 889-895
- Selvi B R, Roy S and Kundu T K (2011) Chemical biology research in India *ACS Chem Biol* **6** 982-986.