Dr. Jhillu Singh Yadav – Scientist par excellence
A Tribute

Dedicated to Dr. Jhillu Singh Yadav on the occasion of his outstanding contribution to organic synthetic chemistry

I feel privileged to pay tribute to Dr. J. S. Yadav, who has been magnificent as a co-mentor (during my initial career as research fellow) and colleague after I joined the Institute as a scientist.

Dr. Yadav was born on the 4th of August, 1950 in Azamgarh, Uttar Pradesh, India. After school in Uttar Pradesh (largest state in India), he Joined Banaras Hindu University, Varanasi (one of the oldest Universities in India) in 1968 and pursued his Bachelors and Masters degrees. He completed his Ph.D in a span of three years from the National Chemical Laboratories, Pune and was awarded a doctorate from Maharaja Sayajirao University of Baroda in 1976 where he was involved in Isolongifolene chemistry under the supervision of Prof. Sukh Dev. He worked as Research Associate at Rice University, Houston, USA and as a postdoctoral fellow at the University of Wisconsin, USA between 1977-1980. He returned to India and joined National Chemical Laboratories as Scientist (1980-1986) and started work on pheromones and fatty acids. In 1986, he moved to the Regional Research Laboratory, Hyderabad (presently known as CSIR-Indian Institute of Chemical Technology) and initiated a new era in the field of synthesis. He became the Director in 2003 and headed the crown institute of CSIR (CSIR-IICT) for 9 years (2003-2012).

The scientific career of Dr. Yadav at CSIR-IICT began with a strong focus on asymmetric synthesis. Initially, he was involved in construction of long chain aliphatic compounds containing acetylene moieties. He believed that outstanding achievement in science should benefit society. In order to address the indiscriminate use of harmful pesticides, Dr. Yadav

pioneered Pheromone Application Technology (PAT) by utilizing insect pheromones, the chemicals released by insects for communication and behavioral response. His contributions in this area had a direct impact whereby insect pheromones were synthesized in the laboratory via unique and viable routes then used to popularize green technology strategies for pest control. Field demonstrations on Ground Nut Leaf Miner (GLM), Brinjal Shoot and Fruit Borer (BSFB), Rice Yellow Stem Borer (YSB) Sugarcane Internode borer (SINB) etc., carried out by Dr. Yadav in collaboration with farmers gained many laurels and the farming community began to appreciate the potential and versatility of PAT. Simultaneously, he established state of the art facilities for conducting pheromone R&D at CSIR-IICT, which was recognized as a **National Center** for pheromone research in India. In fact, it was a successful beginning to agro practice in Indian farming with a great future as an environmental and ecofriendly alternative to pesticides.

Dr. Yadav is one of the most distinguished organic chemists in India. His scientific skills and innovative approaches have paved the way for Indian science to excel in the area of asymmetric synthesis. He nurtured many enthusiastic young scientists in India by developing the art of total synthesis in his group. This exercise was excellent training for budding researchers who excelled in the area of asymmetric synthesis. From the beginning of his research career, he was at the forefront of research in new areas and tackled difficult problems with the deepest insight. His pioneering work on the development of **highly enantioselective synthesis of propargyl alcohol** derivatives from epoxy alcohol and carbohydrates and subsequent investigations over nearly one decade, marked a milestone in his prolific career that resulted in fundamental contributions to asymmetric chemistry in India (Figure 1). This methodology was illustrated by its application to the total synthesis of several long chain fatty acids such as lipoxin A, Coriolic acid, Octadecanoic acid, Sphingenine, Strongylodiol, and Panaxytriol (Figure 2). His work on the de-oxygenation of epoxy alcohols led to the synthesis of a series of trans-3-hydroxy vinyl compounds (Figure 1).

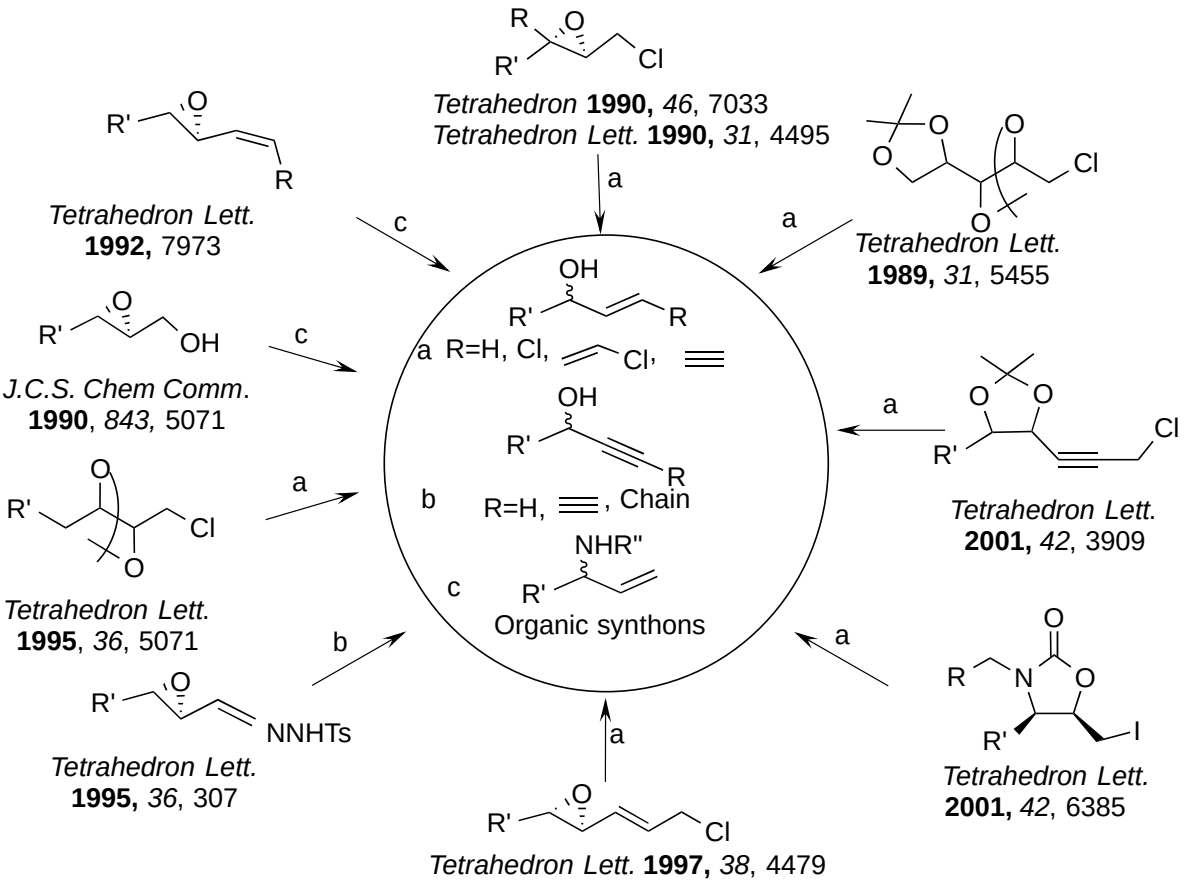

Figure 1. Synthesis of chiral allyl and propargyl alcohols.

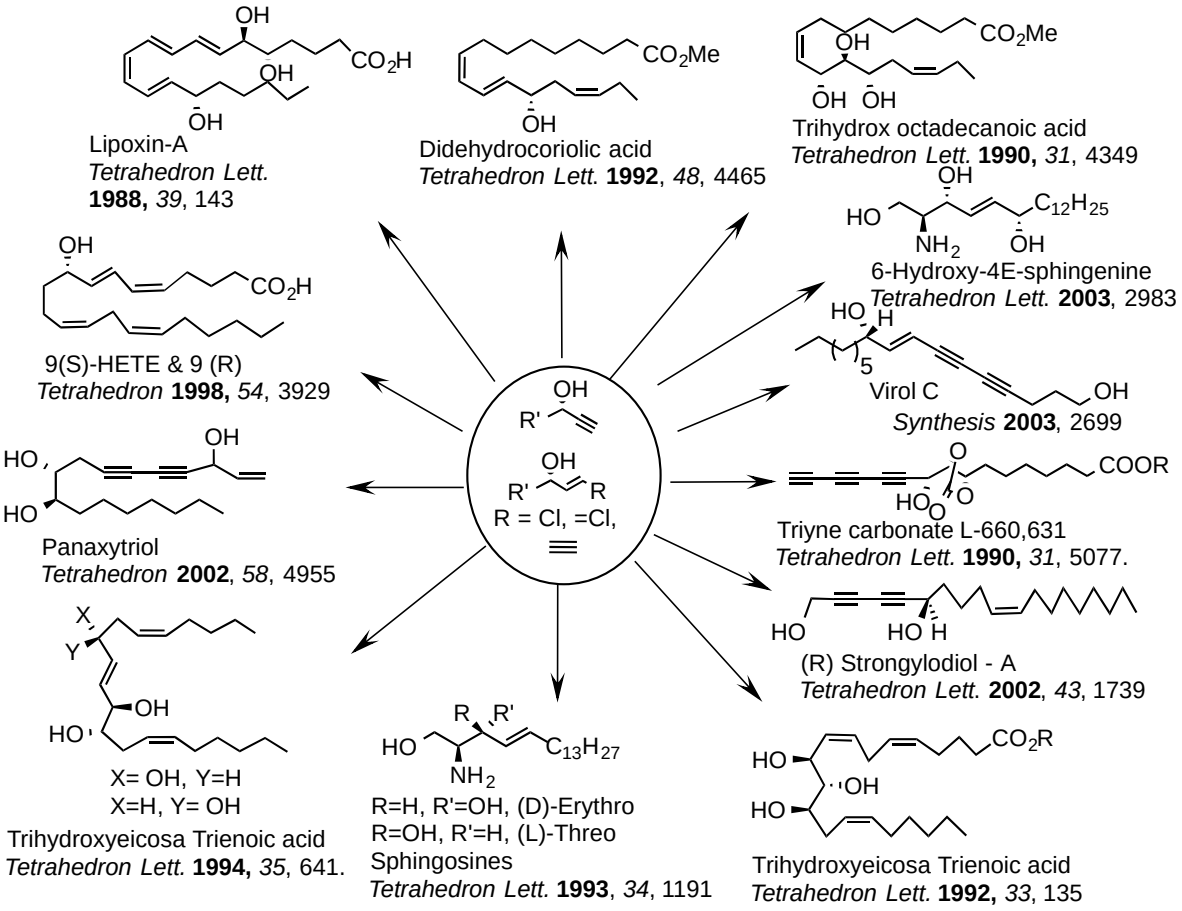

Figure 2. Applications of allyl and propargyl alcohols.

Dr. Yadav's papers dealing with intermolecular [4 + 3] cycloaddition followed by desymmetrization giving rise to five contiguous chiral centers in a highly diastereoselective manner, paved the way to major developments in the utilization of this protocol for the total synthesis of a variety of complex biologically active natural products with multiple chiral centers such as Rifamycin, Discodermolide, Scytophycin, Siphonarin, Methynolide, Azaspiric Acid, Callystatin, Saliniketal A&B, Venturicidin X, Crocacin etc., (See Figure 3 for few structures).

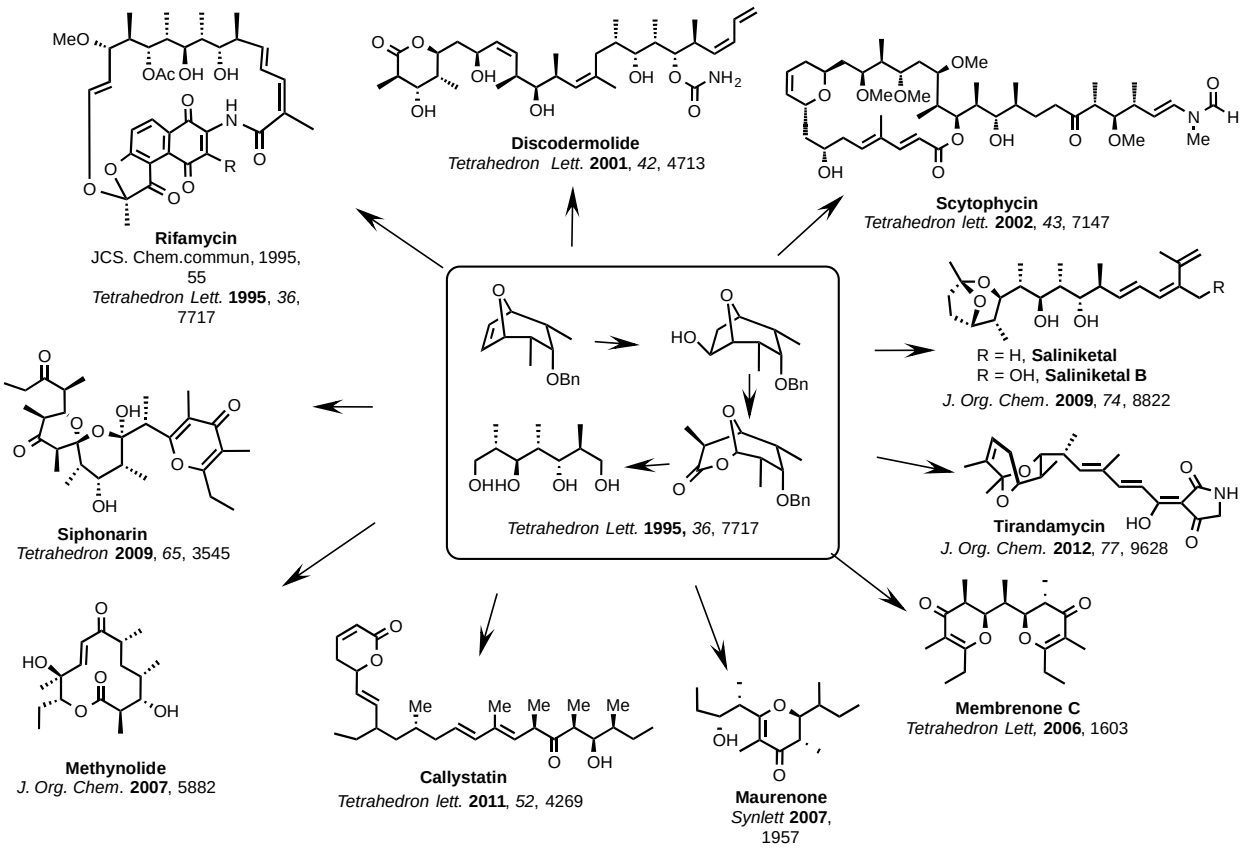

Figure 3

Dr. Yadav was the **first** to develop directed-Prins cyclization protocol for the synthesis of 2,4,6-syn-trisubstituted tetrahydropyran derivatives under environmentally benign conditions and further transformations for the formation of *anti*-1,3-diol, that lead to the total synthesis of a number of highly complex natural products such as Crocacin A, Salicylihalamides A & B, Apicularen A, Tetrahydrolipstatin (Figure 4) which amply demonstrated the value of his approach.

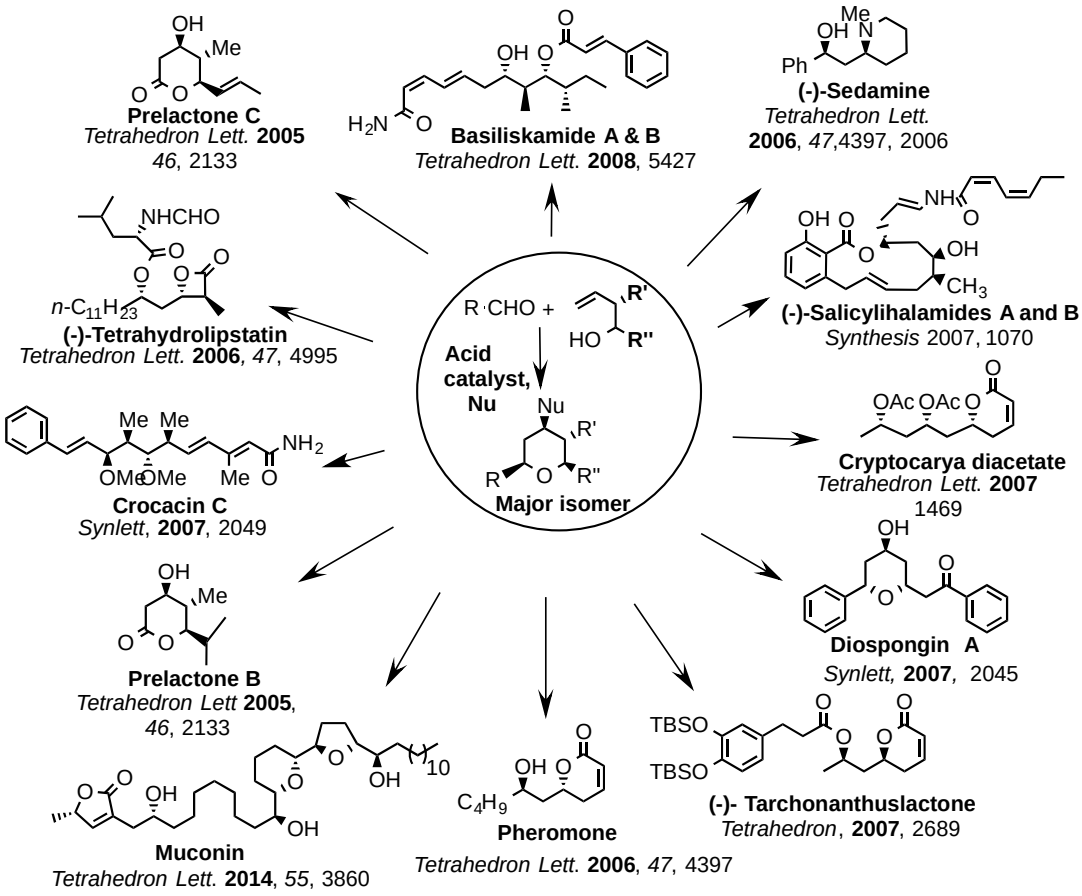

Figure 4

Through his vast expertise in the Chemistry of Natural Products, many programmes and projects were explored on the utility of natural products for human health care at different CSIR laboratories under the project title "Bioactives from Natural Products". The herbal drug standardization programme and Golden Triangle Partnership Programmes on Ayurvedic Products & Bhasmas benefited many Ayurvedic industries such as M/S Arya Vaidya Sala (AVS), Kottakkal; Indian Medicines and Pharmaceuticals Corporations Limited (IMPCL), Mohan; Hamdard Research Foundation, New Delhi.

While working at CSIR-IICT Dr. Yadav has excelled by his outstanding discoveries that have been published in highly reputable international journals. To the best of my knowledge, **he is the only scientist in India** and in all disciplines so far, to publish over **1100** research papers with a *h*-index of 60 and over 20,000 citations during the last twenty years. He has over 150 patents and his academic zeal, and intense dedication to science is an inspiration to his younger colleagues. He still enjoys intensive discussions with colleagues and offers advice to his co-workers. His exceptional ability to remember authors and their contributions in the area of synthetic chemistry over the years has earned him a reputation as a ***walking encyclopedia*** by his coworkers. All these characteristics have attracted many young and highly motivated students to

join him for their PhD programs (190 Ph.Ds have been awarded under his guidance) and resulted in his recognition as the human resources person in the field of organic chemistry. An independent survey by SCOPUS identified Dr J S Yadav as the most productive chemist in India and has contributed considerably to the reputation of CSIR-Indian Institute of Chemical Technology. Consequently, for the last consecutive five years during his leadership, CSIR-IICT has been the number one institute in the field of chemical sciences in terms of publications and Ph.D's produced in India.

Dr. Yadav was invited to several international conferences, symposia and has given several key note/plenary lectures in India. He has traveled across the globe and made significant impact as seen by several collaborative programmes from the places he visited. He is a visiting professor and Elite Advisor, at King Saud University, Saudi Arabia. He is also a visiting professor for the Royal Melbourne Institute of Technology (RMIT), Australia and Distinguished Professor for Banaras Hindu University. Very recently, he was elected to an honorary doctorate from the University of Rennes 1, France for his overall contributions in synthetic organic chemistry.

Dr. J. S. Yadav received India's most prestigious scientific award Shanti Swarup Bhatnagar award in 1991 for his fundamental contributions to synthetic chemistry. Internationally, he received the first 22nd Khwarizmi International Award, from Iran (IROST-UNESCO). Apart from this recognition, he has received several national awards such as Ranbaxy award, Goyal award, VASVIK award, Vigyan Gaurav Samman Award, Vigyan Ratna Award, FAPCCI award, and BHU alumnus award. His contributions have been recognized by several academies who have elected him as Fellow, The World Academy of Sciences (FTWAS), Indian Academy of Sciences (FASc), Indian National Science Academy (FNA), National Academy of Sciences (FNASc), Young Associate, Indian Academy of Sciences etc. Besides being a great scientist and a leader, Dr. J. S. Yadav is a visionary and developed the best infrastructure at CSIR-IICT including National Molbank (sample repository), automation chemistry lab and Integrated Pest Management facilities. Presently, Dr. Yadav is serving at CSIR-IICT as a CSIR Bhatnagar Fellow, a prestigious fellowship in India bestowed on him as a result of his enormous contributions and scientific caliber.

Dr. Yadav has a very happy personal life with wife Janaki Yadav and two sons. Lastly, on behalf of all of his associates, I wish Dr. Yadav and his family members a healthy and fruitful life ahead.

Dr. S. Chandrasekhar, FNA, FASc, FNASc,
Director CSIR-Indian Institute of Chemical Technology,
Hyderabad, Telangana – 500007, India.
E-mail: srivaric@iict.res.in/director@iict.res.in

Selected Publications

1. Yadav, J. S.; Shekharam, T.; Gadgil, V. R. Titanocene induced regioselective deoxygenation of 2,3-epoxy alcohols - a new reaction for the synthesis of allylic alcohols. *JCS. Chem. Commun*. **1990**, *11*, 843**.**
2. Yadav, J. S.; Bhaskar Rao, A.; Tirupathi Reddy, P.; Samik Nanda. An efficient enantioselective reduction of ketones with daucus carota root, *J. Org. Chem.* **2002**, *67*, 3900.
3. Yadav, J. S.; Reddy, B. V. S.; Rao, K. V.; Saritha Raj, K.; Prasad, A. R.; Kiran Kumar, S.; Kunwar, A. C.; Jayaprakash, B.; Jagannath, B. Indium (III) bromide catalysed novel cyclization of glycals with aryl amines. *Angew Chem. Int, Ed. Eng.* **2003**, *42*, 5198.
4. Yadav, J. S.; Satheesh Babu, R.; Sabitha, G. Stereoselective total synthesis of (+) – artemisinin. *Tetrahedron Lett.* **2003**, *44*, 387.
5. Yadav, J. S.; Lakshindra Chetia. Stereoselective total synthesis of bistramide A. *Org. Lett.* **2007**, *9*, 4587.
6. Yadav, J. S.; Manoj Kumar Gupta, Prathap. I.; Manika Pal Bhadra.; Parsi. K. Mohan.; Jagannadh Bulusu. Synthesis and cellular uptake of cell delivering 2,6-pyridinediylbis-alkanamide submicron-sized sheets in HeLa cells. *Chem. Comm.* **2007**, 3832.
7. Yadav, J. S.; Suresh Reddy, Ch. Stereoselective synthesis of amphidinolide T1. *Org. Lett.* **2009**, *11*, 1705.
8. Yadav, J. S.; Satheesh, G.; Murthy, V. S. R. Changalvala. Synthesis of (+)-lycoricidine by the application of oxidative and regioselective ring-opening of aziridines. *Org. Lett.* **2010**, *11*, 2544.
9. Yadav, J. S.; Pattanayak, M. R.; Das, P. P.; Mohapatra, D. K. *Org. Lett.* **2011**, *13*, 1710.
10. Yadav, J. S.; Rajendar Goreti; Srihari, Pabbaraja. Short route to platencin. *Org. Lett.* **2013**, *15*, 3782.

