

# Women's in Chemistry: Making the Difference

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## ***Abstract***

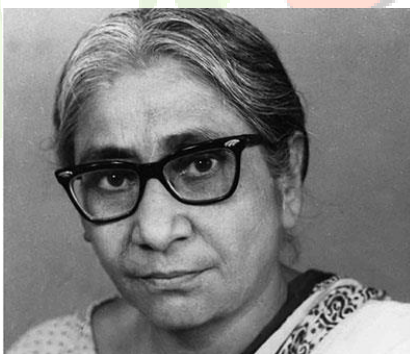
This presentation highlights the life and works of some eminent women scientists in Chemistry and Biochemistry – now no more with us.

The path to eminence was not easy for the pioneers. The pioneering woman scientist in Chemistry was Professor (Mrs.) Asima Chatterjee, the first woman General President of the Indian Science Congress Association. Asima Chatterjee primarily studied the Chemistry and medicinal properties of plants native to India. Her research contributed to the development of drugs that treated epilepsy and malaria amongst others. Kamala Sohoni, of the same generation, was the first Indian woman to earn a PhD degree in Science from Cambridge University. She was one of the earliest scientists working on Biochemistry in India. She became the Director of the Institute of Science, Bombay. Of two succeeding generations Darshan Ranganathan and Charusita Chakravarty made significant contributions to Organic and Bio-organic Chemistry, and Theoretical Chemistry, respectively.

**Key Words:** Women Chemists, anti-epileptic drugs, neera, supramolecular assemblies.

## ***Introduction***

Women empowerment is the progression of women and, accepting and including them in the decision-making process. It also means providing them with equal opportunities for growth and development in society, and disapproving gender bias. Literacy of women is an important key to improving health, nutrition and education in the family.



**Asima Chatterjee (1917-2006)**

Asima Chatterjee is regarded highly for her works in the fields of organic chemistry and phytochemistry (chemicals derived from plants). Her most notable work includes research on indole alkaloids, the development of anti-epileptic drugs and development of anti-malarial drugs. She authored a considerable volume of work on medicinal plants of the Indian subcontinent. She was the first woman to receive a Doctorate of Science from an Indian university.

## **Early Life**

Asima Mukherjee was born on September 23rd, 1917 in Calcutta. Her father Indra Narayan Mukherjee was a doctor and was very supportive of Asima's education, which was rare at that time. Her father loved Botany, this was where she developed her interest in medicine. But, her particular interest in the field of medicine began with her curiosity regarding the medicinal properties of plants.

## Education

In an era when the women did not commonly pursue higher education, Asima chose to study Chemistry. She graduated, with Honours, from the Scottish Church College, University of Calcutta in 1936. She further pursued Masters in Organic Chemistry from the University of Calcutta and obtained her MSc in 1938. She went on to do her DSc at the University of Calcutta. She was the first woman to receive a doctorate at an Indian University in 1944. As a doctoral student, she worked on the chemistry of plant products and synthetic organic chemistry with the renowned chemist, Prafulla Kanti Bose. Prafulla Chandra Ray, known as the father of Chemical science in India, and Satyendra Nath Bose, the famous physicist were her mentors.

She went on to do her post-doctoral work with Professor L.M. Parks, University of Wisconsin, USA (1947-1948) on Naturally occurring Glycosides, then with Professor Laszlo Zechmeister, California Institute of Technology, Pasadena, USA (1948 – 1949) on Carotenoids and Provitamin-A. In recognition of this work she was awarded the coveted Watumull fellowship. She was associated with Professor Linus Pauling, NL, at California Institute of Technology, Pasadena, USA. Then she worked with Professor Paul Karrer, NL, University of Zurich, Switzerland (1949 – 1950) on Biologically Active Indole Alkaloids.

She became Honorary Lecturer at Chemistry Department, Calcutta University in 1944. She later joined the University College of Science at the University of Calcutta as a Reader in Pure Chemistry in 1954. She continued her research on the nature of biologically active compounds found in medicinal plants.

She became Head of Department of Chemistry (1969-1980), then Dean – Faculty of Science (1969-1979). In 1972, she was appointed as the Honorary Programme Coordinator of the Special Assistance Programme (1972-2003), later developing into the Centre of Advanced Studies to intensify teaching and research in natural product chemistry, sanctioned by the University Grants Commission (India). She was Honorary Co-ordinator of the UNESCO-UNDP Assistance Programme to Department of Chemistry (1975-1982). Through her research, she developed anti-epileptic, anti-convulsive, and chemotherapy drugs to treat patients. The anti-epileptic drug - 'Ayush-56'- which she developed from *Marsilia minuta* is used commercially. The anti-malarial combination drug - 'Ayush-64'- has now been found effective against milder cases of COVID-19.

Even after retirement, she continued her academic activities, relocating to new premises, for the construction of which she had arranged funds from the Central Government. Even with increasing age, and consequent deterioration of health she came regularly to the Department, till her demise in November 2006.

In the last two decades of her life she devoted much of her efforts to establish an Institute of research on Traditional medicine. This culminated in the late 1990s to the establishment of the CCRAS Institute now known as the Central Ayurveda Research Institute.

## Awards and Recognition

Nagarjuna Prize and Gold Medal (Calcutta University, 1940)

Premchand Roychand Studentship (Calcutta University, 1942)

Mouat Gold Medal (Calcutta University, 1944)

Sir P. C. Ray Award – Indian Chemical Society (1974)

Shanti Swarup Bhatnagar Memorial Award of the Council of Scientific and Industrial Research - Government of India in Chemical Sciences (1961)

**Elected General President of the Indian Science Congress Association (62nd Session held at New Delhi, January 1975). First woman General President of the ISCA.**

**Honoured with Padma Bhushan by Government of India (1975)**

**Nominated by the President of India as a Member of Parliament (Rajya Sabha) as a Scientist-Academician (February 1982-1984; May 1984-May 1990)**

Sir Asutosh Mookerjee Gold Medal of the Indian Science Congress Association (1989)

Indira Gandhi Priyadarshini Award of the All India Unit Conference (1994)

Silver Jubilee Award of the Central Council for Research in Ayurveda and Sidha, Government of India (1995)

Sir Devaprasanna Sarbadhikary Gold Medal, University of Calcutta (1999)

Eminent Teacher Award of the University of Calcutta (1994)

Rathindra Purashkar of Visva Bharati (1999)

Honoured by the West Bengal Academy of Science and Technology and awarded the Academy Medal (1998)

Honoured Citizen of Calcutta Award by the First Citizen of Calcutta – the then Mayor of Calcutta, Hon'ble Shri Bikash Ranjan Bhattacharyya (2006)



**Kamala Sohoni (18 June 1912 – 28 June 1998)**

**Kamala Sohoni** obtained her PhD in 1939 from Cambridge University. Her acceptance into and work at the Indian Institute of Science, Bangalore, paved the way for women to be accepted into the institution for the first time in its history.

Her research delved into the effects of vitamins and into the nutritive values of pulses, paddy, and groups of food items consumed by some of the poorest sections of the Indian population. Her work on the nutritional benefits of the palm extract called 'Neera' was inspired by the then-president Rajendra Prasad's suggestion. Kamala Sohoni received the Rashtrapati Award for this work.

### **Early Life**

Kamala Bhagwat was born on 8th June 1912 in Indore, Madhya Pradesh, India. Her father, Narayanarao Bhagwat, as well as her uncle, Madhavrao Bhagwat, were chemists and alumni of the erstwhile Tata Institute of Sciences (which later became the Indian Institute of Science) in Bangalore. Kamala followed 'family tradition' and graduated in 1933 with a BSc degree in Chemistry (principal) and Physics (subsidiary) from Bombay University.

Kamala then applied to the Indian Institute of Science for a research fellowship, but her application was turned down by the then-Director and Nobel Laureate Prof. C V Raman on the grounds that women were not considered competent enough to pursue research. Kamala responded to the rejection by holding a 'satyagraha' outside Prof. C V Raman's office which persuaded him to grant her admission, but with three conditions attached:

- She will not be allowed as a regular candidate and will be on probation for the first year also will be known throughout the campus after she succeed her work
- She has to work late at night as per the instruction of her guide
- She will not spoil the environment of the lab (she should not be a 'distraction' to the male researchers)

Although admittedly humiliated by them, Kamala agreed to the terms, thus becoming in 1933 the first woman to be admitted into the institute.

### **Career and Research**

Kamala's mentor at the IISc was Shri Srinivasayya.. She worked on proteins in milk, pulses and legumes (a subject that was especially significant in the Indian context). Her dedication and research mettle influenced Prof. Raman's decision to let women into the IISc a year after she completed her MSc degree with distinction in 1936. She was invited to UK's Cambridge University to work under Dr. Derek Richter in the Frederick G. Hopkins laboratory. She was a student of Newnham College, matriculating in 1937 and studying the Biological Natural Sciences Tripos. When Richter left, she worked under Dr. Robin Hill and studied plant tissues. From her work on potatoes, she discovered the enzyme 'Cytochrome C' which plays an essential role in the electron transport chain (the process by which energy is created for organisms), found in plants, human and animal cells. After receiving her PhD, Kamala returned to India in 1939. She was appointed Professor and Head of the Department of Biochemistry at Lady Hardinge Medical College in New Delhi. Later, she worked at the Nutrition Research Laboratory, Coonoor as Assistant Director, focusing on the effects of vitamins. She joined the Royal Institute of Science as a Professor in the Department of Biochemistry, and worked on the nutritional aspects of legumes. Her eventual appointment to the position of Director of the Institute is believed to have been delayed by 4 years due to existing gender bias in the scientific community. During this period, Kamala and her students conducted

important research on three groups of food items that are majorly consumed by financially disadvantaged sections of people in India.

Kamala started work on 'Neera' (sap extracted from the inflorescence of various species of toddy palms). She found significant quantities of Vitamin A, Vitamin C, and iron in the drink, and that these elements can survive concentration of Neera into palm jaggery and molasses. Later studies indicated that the inclusion of *Neera* in the diets of malnourished adolescent children and pregnant women from tribal communities as an inexpensive dietary supplement led to significant improvement in health.

### **Awards and Recognition**

She was awarded the Rashtrapati Award.

She was an active member of the Consumer Guidance Society of India (CGSI) - for the year 1982-83 period she was elected President of the CGSI

She authored articles on consumer safety for the organisational magazine called 'Keemat'.

In 1998, shortly after collapsing during a felicitation ceremony organised by Indian Council of Medical Research (ICMR) in New Delhi she left for heavenly abode.



**Darshan Ranganathan (4 June 1941 – 4 June 2001)**

**Darshan Ranganathan** was an organic chemist from India who was known for her work in bio-organic chemistry, including significant work in protein folding. She was also recognized for her work in supramolecular assemblies, molecular design, chemical simulation of key biological processes, synthesis of functional hybrid peptides and synthesis of nanotubes."

### **Early Life**

She was born on 4 June 1941. She was educated in Delhi and received a PhD in chemistry from Delhi University in 1967. Joining as a lecturer, she became Head of the Chemistry Department at Miranda College, Delhi, and went on to receive an 1851 Research Fellowship from the Royal Commission for the Exhibition of 1851, to enable her to conduct postdoctoral work at Imperial College London with Professor D.H.R. Barton.

### **Career and Work**

In 1970, she began research at the Indian Institute of Technology, Kanpur (IIT Kanpur). She began work at Regional Research Laboratory, Trivandrum in 1993, and at IICT, Hyderabad in 1998, where she became Deputy Director. During these years, she conducted ongoing collaborations with Isabella Karle at the U.S. Naval Research Laboratory.

She was a Fellow of the National Academy of Sciences. She also won the A.V. Rama Rao Foundation Award, the Jawaharlal Nehru Birth Centenary Visiting Fellowship, Third World Academy of Sciences Award in Chemistry in 1999 for her work in bio-organic chemistry, and the Sukh Dev Endowment Lectureship.

At the time of her passing away, she was the most prolific organic chemist in India, having, in the last five years, a dozen publications in *The Journal of the American Chemical Society*, six in the *Journal of Organic Chemistry* and dozens in others. Her monumental contribution to the *Accounts of Chemical Research* was published, as well as many other papers, posthumously. She was elected Fellow of the Indian Academy of Sciences, Indian National Science Academy and the recipient of many honors the last of which was The Third World Academy of Sciences Award in chemistry for her outstanding contributions to bio-organic chemistry, particularly



supramolecular assemblies, molecular design, chemical simulation of key biological processes, synthesis of functional hybrid peptides and synthesis of nanotubes, in 1999.

Ranganathan's special passion was reproducing natural biochemical processes in the laboratory. She created a protocol which achieved the autonomous reproduction of imidazole, an ingredient of histadine and histamine with pharmaceutical importance. She also developed a working simulation of the urea cycle. As her career developed, she became a specialist in designing proteins to hold a wide variety of different conformations and designing nanostructures using self-assembling peptides.



**Charusita Chakravarty (5 May 1964 – 29 March 2016)**

**Charusita Chakravarty** was Professor of Chemistry at the Indian Institute of Technology, Delhi since 1999. In 2009 she was conferred Shanti Swarup Bhatnagar Prize for Science and Technology in the field of chemical science. In 1999, she received B.M. Birla Science Award. She was an Associate Member of the Centre for Computational Material Science, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore.

#### **Early life**

**Charusita** was born in Cambridge, Massachusetts, USA on 5 May 1964. She was raised in Delhi, India and chose to give up her American citizenship in her twenties. Chakravarty was selected as the National Science Talent Scholar and went on to clear the Joint Entrance Exam (JEE) of the Indian Institutes of Technology (IIT). She did her BSc Chemistry from St. Stephen's College, University of Delhi, standing first. She went on to do the Natural Science Tripos from Cambridge University, UK. Following this, she joined the Doctorate of Philosophy program at Cambridge under the guidance of David Clary. Her thesis was on the spectra and dynamics of Ar-OH, an open shell system that involved a lot of nuances. Charusita then became a Post Doctoral Scholar at the University of California at Santa Barbara, under Professor Horia Metiu. After a brief visit to India, she returned to Cambridge as a Gulbenkian junior research fellow in an independent post-Doctoral position.

#### **Career**

After joining IIT Delhi's Department of Chemistry, where she continued to teach till her death.

Her initial work was related to atomic and molecular clusters and over the course of her career, notable was her specialised application of path integral Monte Carlo simulation to unravel quantum mechanical effects in the properties of atomic and molecular clusters.

Her fields of interest included theoretical chemistry and chemical physics - the structure and dynamics of Liquids, water and hydration, nucleation and self-assembly. International and national journals have published her articles and she was widely known for her single-author papers, published extensively over the course of her career. A few of her co-written works include, *Multiple Time-scale Behaviour of the Hydrogen Bond Network in Water* (2004), *Estimating the entropy of liquids from atom-atom radial distribution functions: silica, beryllium fluoride and water* (2008), and *Excess entropy scaling of transport properties in network-forming ionic melts* (2011).

#### **Awards and achievements**

Medal for Young Scientists from the Indian National Science Academy (INSA) (1996)

Shanti Swarup Bhatnagar Prize for Science and Technology (2009)

B.M. Birla Science Award (1999)

Indian National Science Academy Medal for Young Scientists (1996)

Anil Kumar Bose Memorial Award of Indian National Science Academy (1999)

Fellowship of Indian Academy of Sciences (2006)

Swarnajayanti Fellowship of the Department of Science and Technology (India) (2004)

Served as a member of the *Abdus Salam International Center* for Theoretical Physics, Trieste, Italy (1996–2003).

Associate Member of the Centre for Computational Material Science, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore.

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