NATURE’S ACTION CHEMISTRY

PROF. SABYASACHI SARKAR

Prof. Sabyasachi Sarkar (born May 17, 1947, in Birbhum, West Bengal, India) is a chemist known for his work in bioinorganic chemistry and nanoscience. He studied at Ramakrishna Mission Vidyamandira and the University of Calcutta, then earned his Ph.D. from Gorakhpur University. After postdoctoral research in Germany, he joined IIT Kanpur in 1978. There, he worked as a Senior Professor and later became the Head of the Chemistry Department. Prof. Sarkar’s research has helped us understand metalloproteins better. He worked on models of heat-resistant enzymes and fish enzyme replicas. He also proved that carbon dioxide binds to magnesium in chlorophyll during photosynthesis, confirming a 100-year-old theory. In nanoscience, he developed water-soluble nanocarbons from low-grade coal. These have been used in plant growth, bio-imaging, and drug delivery across the blood-brain barrier. Beyond IIT Kanpur, he has held honorary positions at IIEST Shibpur and Ramakrishna Mission Vidyamandira. He became a Fellow of the Indian Academy of Sciences in 1997. Throughout his career, Prof. Sarkar has worked to advance chemical sciences while mentoring and guiding young researchers.

NOTES OF FUTURE

- **Recreating Nature in the Lab: A Chemist’s Joy:** My scientific journey began with a deep fascination for how nature constructs complex biomolecules. Recreating molecules like adenine from simple building blocks in the lab, using second-row transition metals like molybdenum as environmental catalysts, was not just an achievement, it was a profound moment of connection with nature's own methods. The joy of designing and synthesizing molecules atom by atom and then watching them function like their natural counterparts remains the most fulfilling reward of my research life.

- **Challenging a Century-old Scientific Puzzle:** A persistent question haunted photosynthesis research for a century: does carbon dioxide truly bind to the magnesium centre in chlorophyll? By replicating this chemistry with synthetic porphyrins and verifying it through rigorous 13C NMR studies on natural chlorophyll, we offered concrete proof. It was a tribute to Willstätter's unfulfilled scientific quest. I felt that we not only solved a puzzle but also honoured scientific legacy through modern tools and creative thinking.

- **Developing Sustainable Catalysis for Industry and Environment:** Inspired by the potential of biomimicry, I developed synthetic enzyme models capable of catalysing industrially relevant reactions, like converting acetylene in crude ethylene to useful compounds. These catalysts, mimicking natural enzymes like acetylene hydratase, can detoxify harmful substances and produce valuable products at low cost and with minimal environmental impact. This work represents my vision of chemistry serving both industry and sustainability, creating value while reducing harm.

- **Revolutionizing Drug Delivery with a Simple Idea:** While the pharmaceutical world was focused on receptor-based drug delivery, I envisioned something radically different: a universal "Nano-box" that could carry any drug across the blood-brain barrier, regardless of its type. Inspired by the simplicity of the Bombay dabbawala’s lunchbox, we created a non-toxic, biodegradable carbon-based nano-carrier that delivers drugs safely and is completely excreted within days. This innovation, tested and patented, holds transformative potential, even if current mindsets have yet to fully embrace it.

- **Redefining Reaction Mechanisms with Biomimetic Kinetics:** Traditional chemical mechanisms like the Marcus outer-sphere and Taube inner-sphere fail to explain the unique behaviour of our synthetic atom-transfer reactions. Through my work, I demonstrated that these reactions follow enzyme-like Michaelis-Menten kinetics, emphasizing the formation of enzyme-substrate-like complexes, in the ground state. Despite resistance from reviewers, I hold firm that this understanding opens new paths in catalysis, bridging chemistry and biology more closely than ever before.

- **A Future Dream: Mimicking Nitrogen Fixation:** One of the greatest unsolved challenges I continue to pursue is the biomimicry of nitrogen fixation. Nature converts nitrogen to ammonia at ambient conditions in the root nodules of plants something the energy-intensive Haber-Bosch process still struggles to do efficiently. Cracking this code could revolutionize agriculture and global food security. I remain hopeful that a synthetic model will one day achieve this, proving that even the simplest biological feats can inspire world-changing innovation.

- **Inspiring Minds, Questioning Systems, and Hoping for Change:** Beyond my lab work, I have always believed that scientific creativity needs freedom and encouragement qualities often lacking in our current system. While countries like the US, Germany, and Japan push innovation, we in India are still often caught in a cycle of imitation. I strive to break this cycle by mentoring young researchers to think independently, search passionately, and question boldly. Even if just a few choose the path of genuine curiosity and discovery, that would be a legacy worth leaving behind.

- **Understanding Mosquito Chemistry to Reveal Nature's Ingenuity:** Curiosity led me to explore how mosquitoes use nitric oxide (NO) to feed unnoticed. By modelling the nitrophorin protein, I uncovered how it binds NO in acidic conditions and releases it at blood pH, enhancing blood flow for easier feeding. Then, it binds histamine to suppress irritation until the mosquito is gone. This molecular sleight of hand is a masterclass in biological efficiency, and studying it deepened my appreciation for nature's elegant problem-solving mechanisms.

- **Pushing Boundaries Despite Resistance and Rejection:** Throughout my career, I've often faced resistance when presenting new concepts especially when they challenge established theories or come from outside the dominant academic circles. But each rejection only strengthened my resolve. From atom-transfer reaction models to alternative pathways in catalysis, I have remained committed to scientific truth over popularity. Progress in science demands courage to persist, even when others are unwilling to listen.

- **Calling for a National Scientific Renaissance:** I've observed how deeply systemic issues, including favouritism and intellectual complacency, have slowed our scientific progress. Institutions once envisioned as beacons of innovation have drifted from their missions. Yet I remain hopeful. I believe India has brilliant minds and boundless potential. If we shift our focus from imitation to innovation, provide opportunities for original thinkers, and celebrate risk-taking over safe conformity, we can usher in a renaissance in Indian science one where we are the first to discover, not just follow.

"Science, a poetic philosophy in understanding nature"

– Sabyasachi Sarkar