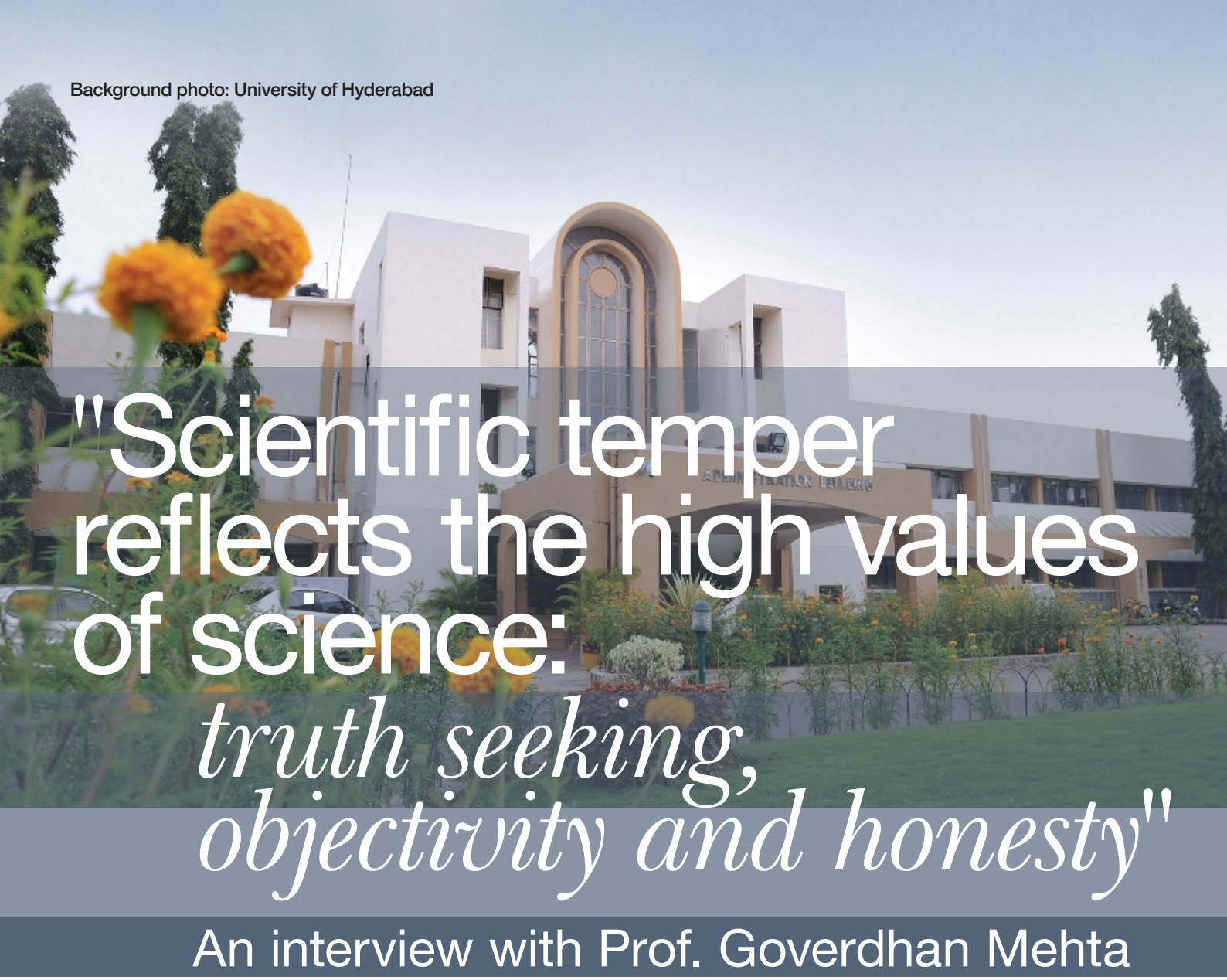
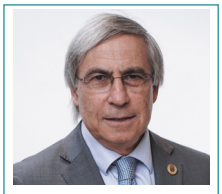


Background photo: University of Hyderabad

"Scientific temper reflects the high values of science: *truth seeking, objectivity and honesty*"

An interview with Prof. Goverdhan Mehta



Ehud Keinan
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By Ehud Keinan
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Goverdhan Mehta was born on 26 June 1943 and received his BSc and MSc from the BITS Pilani and Ph.D. from Pune University. Following post-doctoral research at the Michigan State University under Prof. Don Farnum and at the Ohio State University under Prof. Paul G. Gassman, he joined IIT Kanpur in 1969. From 1977-1998, Mehta was a Professor of Chemistry and Vice-Chancellor at the University of Hyderabad. From 1998-2005 he was the Director of the Indian Institute of Science. Since 2010, he has been a distinguished university professor and Dr. Kallam Anji Reddy Chair at the Department of Chemistry, University of Hyderabad. Mehta has authored over 550 research papers.

Mehta served as President of the Indian National Science Academy (1999-2001), Co-Chair (with Bruce Alberts) of the Inter Academy Council (IAC) (2000-2005), President Chemical Research Society of India (2002-2005), President of the Association of Indian Universities (2003), President of ICSU (2005-2008), and Chairman, National Committee for IUPAC (1991–93). Mehta is a recipient of nearly 40 Honorary Doctorates and multiple prizes, including the Nehru National Award for Excellence in Science (1994), the Humboldt Prize (1995), the Acharya P.C. Ray Medal (1995), the Padma Shri Prize (2001), the TWAS Medal awarded by World Academy of Sciences (2001), C. V. Raman Medal (2003), Legion of Honor awarded by Republic of France (2004), Centenary Prize awarded by Royal Society of Chemistry (2005), G. M. Modi Award (2007), Order of Merit of the Federal Republic of Germany (2016), and INSA Medal for Promotion and Service to Science (2017).

Goverdhan Mehta is a Fellow of global organizations, including the Indian National Science Academy, the Indian Academy of Sciences, the National Academy of

Sciences, the World Academy of Sciences, the Royal Society, the Russian Academy of Sciences, the World Innovation Foundation, the Royal Society of Chemistry, and the Indian Chemical Society.

Following my curiosity, Goverdhan Mehta admitted that he has no family relationship with the famous Indian conductor Zubin Mehta, previous music director of the Israel Philharmonic Orchestra and conductor of the Los Angeles Philharmonic. I interviewed Goverdhan Mehta via Zoom.

EK: Most young people in every country are interested in role models, which is why we give prizes and awards. We want to create role models for the young generation. People would like to know more about them, and this kind of interview triggers many readers' curiosity. They want to understand what motivates successful people, why they do what they do, etc. How early in your childhood has science triggered your curiosity?

GM: As I recall, flares, colors, and fumes that emanated from the firecrackers used during festivities in India and observing a neighborhood 'Ayurveda' physician mixing, grinding, feeling, and smelling exotic plant herbs were possibly the adventitious triggers to arouse my curiosity and early exposure to the 'science/art of mixing substances'. Although in grade 3 when I was 7-8 years old, I had heard words like chemistry and science, I had no idea what they were all about.

EK: To understand what attracts young people to science, we often see that curiosity about science starts very early in life. For example, Yuan Tse Lee was amazed by the tin foil flakes that American warplanes dropped to confuse the Japanese radar system in WWII. Ryoji Noyori was impressed by a lecture on the discovery of nylon, and Eiichi Nakamura was impressed by the beautiful crystalline minerals found by his father, a mining engineer. Do you remember a singular event of personal experience in your childhood that attracted you to chemistry?

GM: On a vacation, my parents took me to visit a petroleum refinery and a pharma plant, and on seeing their production lines to create newer chemicals, it dawned on me that substances can be manipulated to unravel more unique features and that experience kindled my interest in studying chemistry and in exploring the science of transformation of chemical matter.

Attraction to science emanates from the social environment, early exposures, and innate traits that need to be further cultivated and nurtured with intermittent boosts to sustain that interest. We were under long colonial rule; therefore, our familiarity with many latest advances was modest, but as a free nation, hopes and aspirations were running high.

I used to wander the streets and was attracted by the colors, rich smells in Nature, and pungent taste of spices. On many festive occasions, we had fireworks displays. Their sounds, radiant flares, and irritating odors drew my attention and aroused my curiosity. At a young age, everyone needs different stimuli to trigger their traction toward science; in my case, it was the mundane experiences of daily life. This resonates with the views of Bruce M. Alberts, former president of the National Academy of Sciences, USA, and author of an influential textbook "Molecular Biology of the Cell' that science education is an informed community process based on how the scientific enterprise works rather than as a collection of facts. This approach augers well for cultivating and sustaining interest in science.

EK: When and why did you consider choosing a science career?

IGM: I decided to study science in high school as India had emerged as an independent nation. Science and 'scientific temper' became famous as an essential learning and attitude in our country. I was attracted to the method and values of science as much as to the vast expanse of opportunities it offered for creative endeavors. I was generally opposed to things that were either too abstract or mechanical or involved bureaucratic engagements, so a career in science was a compelling option. In retrospect, this was the only sensible decision I have been able to take in my life!

"Attraction to science emanates from the social environment, early exposures, and innate traits that need to be further cultivated and nurtured."

EK: Did you receive appropriate formal education to become a scientist?

GM: My training in science till my Masters degree was in public institutions and quite adequate but not elite or exceptional. However, my doctoral research was at the National Chemical Laboratory, Pune, a premier institution in the country, with a renowned organic chemist Dr. Sukh Dev as my mentor. Thus, my formal exposure to science was appropriate for the early post-colonial times in India, and I felt privileged to be an entirely 'homegrown' scientist.

EK: I understand you were a lucky kid from a family of educated people. How supportive was the family of your choice?

GM: My Father was an agricultural scientist with a Master's degree in botany but later migrated towards soil science. As a kid, I often went to his lab where I could play with

Figure 1. Intervention at a recent (March 2023) symposium

flasks, beakers, pipettes along with some gadgets used to estimate elements in the soil. These exposures, I suspect, must have activated some of the dormant genes in me and seeded my interest in chemistry.

My mother was a wise woman with an analytical mind but she remained a homemaker and subtly influenced my journey without being persuasive about career choices. Recognizing my aloof, independent, and uncompromising traits, my parents felt that such a temperament was better suited for a scientist. They fully supported my decision for a career in science and encouraged me to limp along, although they were under societal pressure to goad me into a career in bureaucracy

EK: Why did they try to convince you to develop a career in bureaucracy?

GM: It was quite understandable, given the times I grew-up in the early years of our independence. My parents had seen the power of the bureaucracy in the colonial era. They thought that choosing that route would ensure high societal standing, influence and income.

EK: I sense that being an independent Indian scientist during the early days of the post-colonial era, and still now, involved a lot of national pride. Were national pride and independence driving forces in your choices?

GM: That is fairly accurate, particularly in the early days of independence, our first Prime Minister, Jawaharlal Nehru was an ardent promoter of science and supported the idea of 'Scientific Temper' and scientific career was considered a matter of pride for advancing the nation. I was attracted not only to science but also to its method, values and ethos. The scientific temper mandates a commitment to objectivity, search for truth, rational thinking and they are its core attributes. Post-independence, we were aspiring to be a value-based country with a prominent role for science for nation building.

> "We, chemists, must re-imagine and re-ideate our discipline and align it to solve significant global challenges without compromising its core strengths and creative elements."

EK: That is a fascinating component in Indian science, and when I think of how to motivate young Indian kids to become scientists, national pride seems to be an exciting element, similar to the approach we take in my country. National pride encourages young Israeli kids to become Israeli scientists. Related to that, your mentor, Prof. Sukh Dev, a national hero, is now approaching his hundred's birthday. I met him at least once in the past and was impressed. Can you share your experience with him and his influence on you and your career? Sukh Dev has attracted my curiosity, and I take this opportunity to interview him indirectly through you.

GM: Dr. Sukh Dev an outstanding scientist and a great mentor and for me has been a fountainhead of encouragement and inspiration. He led by example, embodied many talents, always very methodical and thorough, remarkably disciplined and deeply committed to a value based pursuit of profession. We see many scientists rushing through experiments and publishing papers to fast track identity and achievements, conveniently compromising on some values and method of science in practice and conduct. Dr. Sukh Dev's life taught us otherwise and his approach in this regard was exemplary and worthy of emulation.

Prof. Sukh Dev believes in acquiring knowledge for learning and for the public good to be shared and propagated in the true Indian tradition and was opposed to its pursuit of personal glory. He should be recognized more nationally and internationally for his outstanding contributions to natural products chemistry, but perhaps his modesty, low-key profile, and aloofness proved self-limiting.

EK: Sukh Dev could probably achieve much more if he worked in the USA or Europe. Did he ever consider relocation?

GM: Certainly, the constraints for frontline research in Indian labs at that time were quite apparent as they lacked modern instrumentation. A person like Sukh Dev could have developed a much more influential and productive career oversees but he was a strong nationalist and committed to advance Indian science.

EK: I see some analogies to the state of mind of Indian and Israeli scientists. The Israeli science heroes who shaped Israeli science have done most of their work in Israel with Israeli students. What attracted you to synthetic organic chemistry?

GM: I was influenced by visits to chemical industries during my high school days. I had a chance to visit a crude oil refinery where I saw these giant columns, big tanks, and flares through tall chimneys. I was fascinated, although I couldn't fully grasp what they were up to. Still, I understood that they were transforming and purifying fossil fuels into other utility products - something originating from Mother Earth's bosom into new things that humankind could use to enhance the quality of life. I realized that chemistry is a powerful tool for productive molecular-level transformations. Later during my doctoral research, I had the opportunity to listen to many inspiring lectures, and many seminal syntheses appeared from Woodward, Corey, and Stork groups, among others, through the confluence of logic and creativity that fascinated me and kindled my interest in synthetic organic chemistry - the art and science of making molecules.

EK: How did you develop an interest in the footprint of chemistry on our environment and green chemistry?

GM: To be honest, this exposure and understanding of environmental and major issues related to sustainability aroused my interest a bit late when these issues began to be on the global policy agenda, mainly during my long association with the International Council of Science (ICSU). I could realize that while chemistry was part of the problem but if harnessed imaginatively, it was also a solution provider for most of the burning issues related to sustainability.

During the international year of chemistry in 2011, I delivered very many lectures titled

'understanding the dimensionality of chemistry – a 21st-century science' to highlight the pivotal role chemistry as a 'central science' can play in addressing global issues related to food security, climate change, one health, sustainable energy to name a few by leveraging its unlimited interdisciplinarity. We, chemists, need to re-imagine and re-ideate our discipline and align it to solve significant global challenges like SDG's without compromising its core strengths and creative elements. Since then, I have begun to focus my outreach efforts on positioning chemistry as a sustainability science.

Since 2015, I have got associated with an international group 'Chemists for Sustainability(C4S)' with likeminded colleagues like Professors Alain Krief, Henning Hopf, and Stephen Matlin under the umbrella of the 'International organization of chemistry for development (IOCD)' to reposition and promote chemistry as 'sustainability science' and we have been regularly writing on many emerging contemporary themes related to sustainability that interface with chemistry.

EK: We chemists create problems but are the only people who can solve them. I saw that you had spent much time in public service, and the ICSU was just one of those assignments. What about the Inter-Academy Council?

GM: The Inter-Academy Council (IAC), which included leading national Academies worldwide, was a product of the 'World Science' conclave held in Tokyo in 2000. The founders decided that, among other things, the voice of science in policymaking, science education, gender equity, and inclusion should be promoted worldwide and receive urgent attention. Bruce Alberts and I were elected as the first co-chairs. I note that IUPAC is also involved with many similar efforts of interest to the chemistry community and take the opportunity to congratulate you on being its incoming president.

EK: Thanks, and related to IUPAC priorities, did you try to promote a specific agenda while serving as president of the Indian National Science Academy?

GM: Our Academy (INSA) covers mainly STEM areas but this is rapidly changing and is providing more connections with other knowledge streams. My own inclination was to coalesce all knowledge streams for human and planetary good and bring in more equity and inclusion through appropriate policy frameworks to achieve this broad objective. We initiated efforts but this quest is still work in progress. I recall that we also seeded efforts towards enhanced engagements with society, policy makers and young scientists in addition to the normal science promotion activities.

EK: Related to your service in the advisory committee to the Prime Minister, can you share your experience and challenges there?

GM: We looked at the entire science landscape in the country in a more wholesome manner in the backdrop of emerging global advances in the STEM arena. We devised many programs for science promotion and engagement of science and scientists with the agenda of national development and enhancing opportunities and quality of science education. One key recommendation was establishing an autonomous National Research Foundation like NSF in USA or ISF in Israel to advance and expand cutting-edge S&T activities and concurrently create opportunities for identifying and nurturing talent.

EK: What are your most significant scientific discoveries?

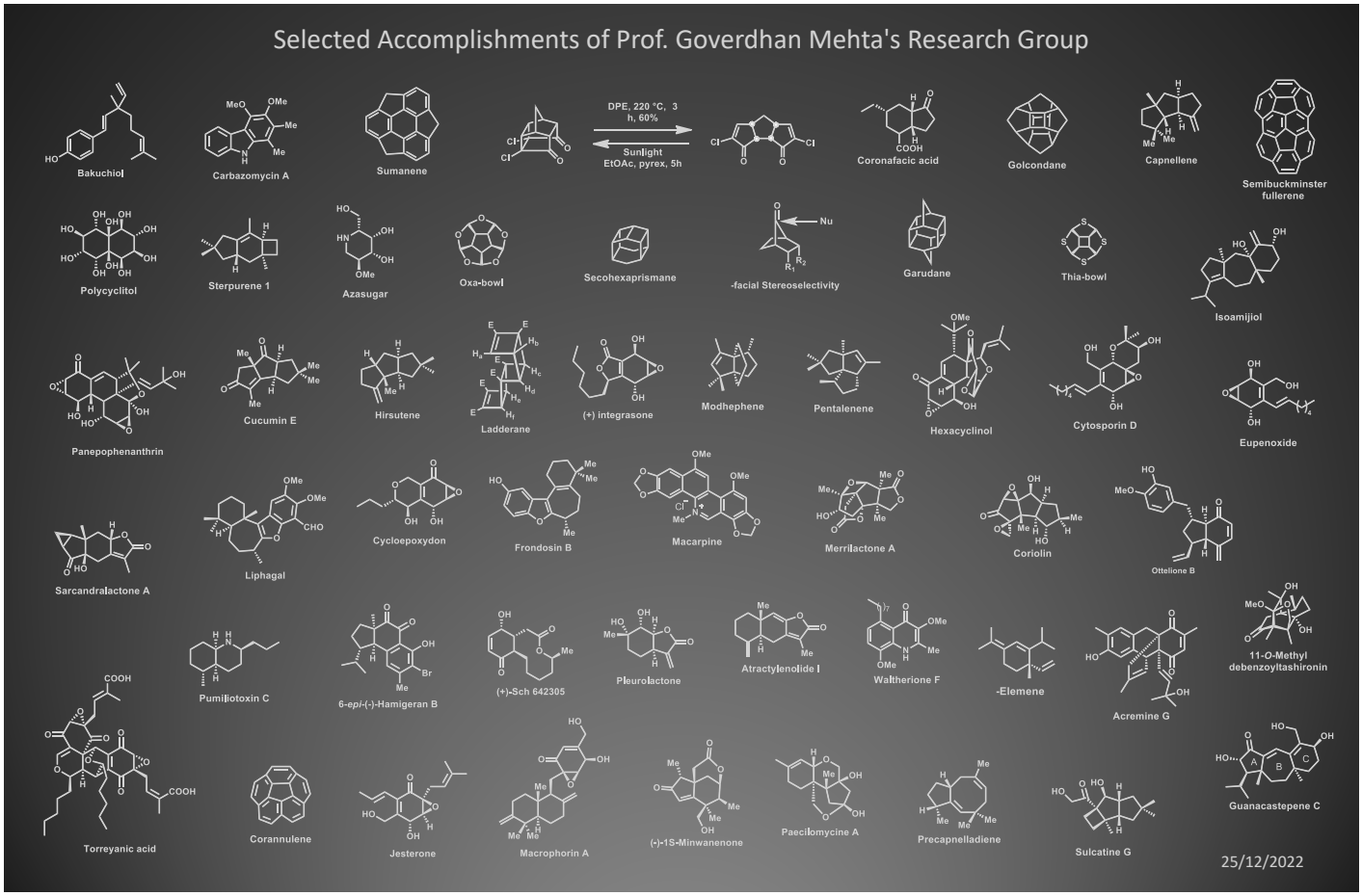

Figure 2. Collage of molecules synthesized by the Mehta group

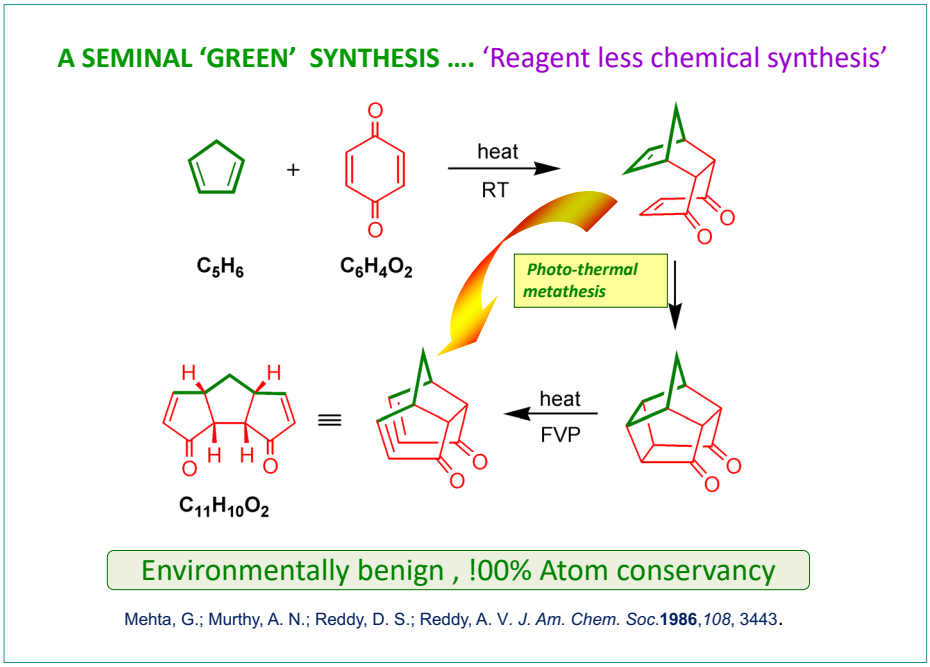

Figure 3. Discovery of Photo-thermal Metathesis

GM: I had diversified and shifting research interests in organic chemistry, dictated by emerging topical trends in chemistry, the prevailing realities in Indian laboratories, and my hunger for doing something different at a competitive level. However, my forte in research has been the total synthesis of complex, bioactive natural products, particularly those that pose a challenge in framework construction, nuanced with intricate or unusual functional and stereochemical features. Thanks to my exceptionally committed coworkers (over one hundred), it was possible to generate many innovative and practical methodologies that culminated in the total synthesis of over seventy natural products in a competitive space.

A gratifying, early contribution in this arena was the discovery of photothermal metathesis, transforming two tabletop building blocks into functionalized triquinane products using only sunlight and heat as the reagents and eventuating in the product with 100% atom economy. Although discovered in the 1980s, finding a better example of green chemistry is still awaited. Natural products based on triquinane framework were receiving much traction at that time and brought us considerable visibility. Even today, synthetic chemists continue to strive for reagent-less complex chemical transformations.

We have been equally interested in conceptualizing and creating newer, aesthetically pleasing chemical entities that resemble familiar high-symmetry geometrical or everyday life objects. We were interested in their molecular 'avatars' like hetero-bowls of varied shapes and sizes, nanoscale oligomers of cyclobutadiene (ladderanes), and bucky bowls like flower-shaped heptacyclic framework (sumanene). This list includes the mythical flying bird-like molecule (garudane)-a designer face-to-face dimer of norbornadiene, seco-hexaprismane-closest to an imagined face-to-face hexacyclic dimer of benzene, and a deca-hydroxydecalin, to name some. We have also deep-dived into aspects of stereogenesis and presented a model for electronic control of face-selectivity in sterically neutral environments and made some forays into supramolecular architecture in the solid state.

EK: What were the Eureka moments in your career?

GM: I cannot recall any specific instance that I could identify as a Eureka moment. I believe chemistry is intrinsically an incremental science that advances through the queer combination of insightful observations, inspirations from Nature, and flashes of creative instincts and rarely through disruptive, game-changing interventions. To me, chemical transformations, the bedrock of chemistry practice, are a continuum in a perpetual quest for perfection. Such goals include reagent-less transformations with full circularity and speed, zero environmental footprints concurrently factoring-in sustainability issues. For me, accomplishing a total synthesis by accessing a competitive natural product target for the first time or creating a molecular equivalent of a familiar object and unraveling its utilitarian potential have been moments of joy and kept recharging me to pursue my interests. Inevitably, there were failures and disappointments too, like our audacious quest for a classical synthesis of C60-buckminsterfullerene or C20-dodecahedrane, as we were piped after making considerable advances. That is the way it is in total synthesis campaigns but the joy of all this is worth living.

"My forte in research has been the total synthesis of complex, bioactive natural products, particularly those that pose a challenge in framework construction."

EK: You seem too humble to answer the question if you had any Eureka moments. Such moments are not reserved only for great discoveries, such as Einstein's formula for converting matter into energy. I'm sure that every time you saw the first NMR spectrum of your target molecule, you jumped up and down with joy in your office.

GM: I had quite a few moments of joy in my career, but I am not sure I would call them 'Eureka moments'. Indeed, when I saw for the first time the NMR of a long-desired molecule, I literally jumped up and down in my office! Very early in my career, I got attracted to photochemistry though we had no access tophotochemical equipment, so I decided to try reactions under sunlight as India is blessed with plenty of it. We ended discovering the Photothermal Metathesis and used it to synthesize a class of compounds bearing a fused 5-5-5 ring system which were very popular at that time. This was a competitive field at the time and our approach became highly noticed and cited. But, the most noteworthy aspect, which we realized only later, was its relevance to the concept of Green Chemistry, which was unknown at that time. Our Photothermal Metathesis became one of the best green reactions because it doesn't require any reagents, and proceeds with 100% atom economy. That work of the early 1980s vintage, I can possibly and humbly identify as my Eureka moment.

Figure 4. From left, a) at the bench as a post-doc, b) audience interaction at an international event, c) receiving D.Sc (h.c) from the President of India, d) former students reunion (Dec 2022).

EK: As Ph.D. students in the 1970s, we appreciated Indian papers on synthetic methodology because we knew they were reliable and easy to perform. We knew that Indian researchers did not have fancy equipment and modern labs, so we trusted the reported protocols. Did you try to promote science and education in India and abroad?

GM: Yes, in my humble way, I have been involved in promoting science, its values and ethos and science education through various policy inputs. I was involved in crafting innovative pathways for research support and researchers' career advancement through various national and international funding initiatives. My association with leading international science organizations like ICSU as its President (2005-8) and Inter Academy Council as its Co-Chair (2000-05), and in my own country through premier National entities, such as the Indian National Science Academy, as President (1998-2001) and the Chemical Research Society of India as President (1999-2002), and as member of the Scientific Advisory Committee to the Prime Minister, (2005-14), providing opportunities for creativity and formulating strategies for rendering service to science in my own humble way.

More recently, since 2015, through IOCD and as part of an international group, I have been actively involved in efforts to promote and position chemistry as a sustainability science through extensive writings on topical themes related to the sustainability of people and the planet, wherein chemistry has a pivotal role.

EK: Did you try to influence the young generation to choose a career in science, and how?

GM: India is endowed with a rich tradition of learning, scholarship, and knowledge sharing that can be traced back several millennia. This enviable legacy has survived but needs to be rejuvenated, prioritized, and synchronized with the present status of knowledge, leveraging our cultural diversity and demographic dividend, particularly in the STEM arena. Efforts have been underway to build upon that legacy.

I have done my bit through regular participation in various science outreach programs, societal engagements, and involvement with science policy issues at various national and international fora. I have for decades regularly and extensively lectured and interacted with young scientists in idea exchanges and inspirational chat sessions to enthuse them toward a career in science. More recently, my focus has been on thematic landmark events like the international year of Chemistry (IYC 2011), UN SDGs (2015-) International Year of the Periodic Table (IYPT 2019), and I have delivered dozens of lectures and held fireside chat sessions with a young audience to seed and nurture their interest in science. At this stage of my professional life, promoting science and chemistry is my priority over advancing my research agenda.

"India is endowed with a rich tradition of learning, scholarship, and knowledge sharing that can be traced back several millennia. This enviable legacy has survived but needs to be rejuvenated, leveraging our cultural diversity and demographic dividend."

EK: Did you try to make the world a better place, and how?

GM: That should be the endeavor of every thinking human being on our planet, but this is too lofty a question for me to address. But chemical sciences can make a difference through their robust societal engagement and connection with policymakers. For such a thing to actualize, chemistry must be repurposed, re-mandated, and positioned as the Sustainability Science to make our world a better place and provide an opportunity for chemistry to make amends for many of the negatives that have come to be associated with it.

EK: Would you like to share your personal life and family?

GM: I've been married for over 50 years, and my wife has mainly been a homemaker who has done a lot of social services and engaging with diverse people. For the last 25-30 years, I've held positions as head of various institutions. Usually, the wife of an institutional head is an ex-officio member involved in social activities on campus. We don't call it that way, but it's like being a first lady. She had been heavily involved in the campus social life and endeavored to bring people together for good causes. We have two children, a daughter (50) and a son (45), and both hold a poor opinion of their father and his profession. As children, they always said, "you have no social life, you don't take us to movies, you don't take us on vacations and despite working all the time, you have no money. So, what kind of profession is this?" And they were right on facts!

Both studied management at India's top institutions and decided to enter the corporate sector and both are doing well - certainly richer than me!. Our daughter was an executive in the citi bank and later became an entrepreneur, starting her own company named 'Crossover Catalyst', a non-profit company that advises and attracts various corporates towards social responsibility and philanthropy.